SURGERY
GYNECOLOGY AND OBSTETRICS
An International Magazine, Published Monthly

VOLUME 66 JANUARY, 1938 NUMBER 1

HURTHLE CELL TUMOR OF THE THYROID GLAND

ABRAHAM O. WILENSKY, M.D., F.A.C.S., and PAUL A. KAUFMAN, M.D., New York, New York

THE established value of clinico-pathological studies has prompted us to report 2 cases of an unusual thyroid tumor which, because of its relative rarity and undetermined clinical significance, should be added to the meager relevant literature so that one may arrive at certain conclusions from the examination of the collective experience.

The following questions will be discussed: (1) The cell of origin of the Hurthle cell tumor; (2) the important clinical phenomena associated with this tumor; (3) the relationship of the tumor as regards its benignity or malignancy; (4) the treatment; and (5) the value of radiation therapy.

GROSS AND MICROSCOPIC ANATOMY

The question of cell classification of the Hurthle cell type of neoplasm with special regard to the cell prototype has not yet been definitely established. The most likely sites of origin are the cells of the thyroid or of the branchiogenetic structures, especially the parathyroids.[1]

The thyroid. It has always been difficult to differentiate the normal elements of the thyroid because of the extreme lability of its cellular elements. Variations in size and structure occur from day to day, and according to the season, the climate, the geographical location, age, sex, food, the state of nutrition, and, most important of all, in accordance with the amount of available iodine.

In mammals the thyroid consists of two lobes which lie on either side of the trachea, about the level of its juncture with the larynx. There is marked variation in its position, both in different, and within the same, species. The human thyroid in particular varies greatly from the theoretically normal type. Complete absence of the thyroid anlage has been observed (Maresch, 1898; Erdheim, 1904). A third "pyramidal" lobe occurs commonly. Isolated masses of thyroid tissue are found along the line of descent of the thyroglossal tract usually known as "lingual," "sublingual," "suprahyoid" and "infrahyoid" thyroids. Accessory or aberrant thyroid tissue apart from that developed from the thyroglossal tract occurs commonly in man in the region of the ascending and transverse portions of the aortic arch. More rarely thyroid fragments are present in the thymus, at the bifurcation of the trachea, or as far down as the esophageal opening in the diaphragm.

There is some doubt as to the single and median origin of the thyroid in mammals. In all other vertebrates the uniformity of the origin of this gland has long been established by the work of Stieda (1881), Born (1883), His (1885), Kastschenke (1887), Van Bemmelen (1889), Maurer (1888, 1889), and Herrmann and Verdun (1900). The thyroid gland is developed from a median diverticulum on the summit of the tuberculum impar which grows downward and backward as a tubular duct, which subsequently divides into a series of cellular cords, from which the isthmus and lateral lobes of the thyroid gland are developed. The ultimo-branchial bodies from the fifth pharyngeal pouches are enveloped by the lateral lobes of the thyroid gland

[1] We are indebted to Keibel and Mall's Embryology, to Cowdry's book on Special Cytology, and to Gray's Anatomy for the embryological, anatomical and microscopic data which follow.

and atrophy and do not form true thyroid tissue. The thyroglossal duct which connects the diverticulum with the pharynx undergoes degeneration and disappears later; its upper end being represented by the foramen cecum of the tongue, and its lower by the pyramidal lobe of the thyroid gland.

The development of the thyroid anlage usually occurs as anastomosing solid cords which are cut up by the ingrowth of vessels and stroma to form a follicular structure. The primary follicles arise by the rearrangement of the cells, cell proliferation, increases in the size of the cells, and lumen formation. The further growth of the thyroid requires the formation of new follicles from the primary follicles. These are usually formed from solid epithelial bands or hollow buds the cavities of which are at first continuous with the original follicle lumen.

The unit of the thyroid is the individual follicle. The follicles are irregularly rounded or elongated closed spaces of variable dimensions lined by a single layer of cuboidal epithelium resting on a condensed layer of connective tissue which, however, is not considered a true basement membrane. Langendorff and all subsequent observers have demonstrated two types of cells: (1) a majority of chief cells and (2) a minority of colloid cells. There is a variable distribution of the colloid cells and occasionally whole follicles may be composed of these cells. The evidence which is at present available would indicate that the chief cell, the Bensley (filled colloid) cell, and the Langendorff (empty colloid) cell probably represent stages of the secretory cycle through which the characteristic thyroid cell passes.

There are variable groups of small follicles and undifferentiated thyroid cells lying between the larger follicles. Most numerous during fetal life and infancy they normally decrease or disappear with age. They may be considered as new follicles in various stages of development as a result of increased growth stimulation whenever a sufficient stimulus for increased thyroid activity is applied, which usually happens in association with goiter formation.

Actively phagocytic reticulo-endothelial cells (tissue mast cells of the older workers) occur also in the interfollicular stroma. According to Williamson and Pearse (1926), they are more prominent in the hyperplastic gland, and these authors assume that they take part in the normal activities of the thyroid. These cells have no morphological relationship to the Hurthle type cell.

Large oxyphilic cells are also described by Hurthle, Baber, Langendorff, and others as occurring in the interfollicular spaces of the normal thyroid. There is no uniformity of opinion concerning these cells, however.

The parathyroids. The parathyroid bodies are developed as outgrowths from the third and fourth branchial pouches. In connection with the fourth parathyroids a cystic entodermal rest corresponding to the postbranchial or ultimobranchial body or lateral thyroid anlage may usually be found. Normally, there are four glands situated two on either side, very difficult to recognize and find; there is very little variation from this normal.

Microscopically the parathyroids consist of intercommunicating columns of cells supported by connective tissue containing a rich supply of blood capillaries.

The parenchyma of the parathyroid is made up of closely packed, relatively large cells. Three types of cells are distinguishable: (1) chief cells; (2) small dark chief cells (Peterson, 1903; Getzowa, 1907; Noodt, 1922); and, (3) large, bright oxyphilic cells (Welsh, 1898).

The clear chief cells appear to be the essential type. They have clear almost unstaining, plant-like, non-granular protoplasm with relatively large, pale vesicular eccentric nuclei.

The dark chief cells are at best only a subgroup of the chief cells and in appearance they are intermediate between the clear chief cells and the oxyphil cells. There seem to be suggestions that they represent the early stages of the large oxyphil cells.

The oxyphil cells appear in late childhood, are much larger than the chief cells, occur singly or in groups, and are characterized by large amounts of granular protoplasm which stain intensely with acid dyes. The nucleus is much smaller than in the chief cells and the chromatin filaments are closely packed and deeply staining.

In infancy only clear chief cells or dark chief cells are present; oxyphil cells are present only in certain species of animals and in man they increase from about the tenth year of life onward. Three types of cells represent different stages of secretory activity, the oxyphil cells being the mature cells.

HISTORICAL REVIEW

With this anatomical background of the various cell types and structures to be considered in determining the origin of the so called Hurthle cell tumor, we review the reported cases in order to reveal their common features.

As was indicated previously, Hurthle, in 1894 described a large oxyphilic parafollicular thyroid cell as a part of the structure of the normal thyroid gland. He did not describe any thyroid tumors composed of this cell type but the similarity between the cell he described and that forming the prototype of the tumors we are discussing prompted later writers to designate them by the term "Hurthle cell tumors."

The first reference to these tumors was made by Langhans in 1907, who applied the descriptive designation "small alveolar, large cell struma" to them. He reported 5 such cases, the histories of which are abstracted here:

CASE 1. From Professor Kocher: Female, aged 55 years, had a colloid struma of the isthmus which had been growing rapidly in the last 3 months. Two nodules were noted, one walnut sized; one 9 by 5½ by 4½ centimeters, each with smooth surfaces. On section, there was noted a lobular structure of gray, brown, red color, translucent, very granular, and with radiating septa containing transected vessels. There was evidence of recent hemorrhage in both nodules.

CASE 2. From Professor Niehaus: Male, aged 68 years, had had a goiter for 15 years. Respiratory difficulty had been noted for 1 year, and had become worse in the last 3 weeks with rapid growth of tumor. Exitus occurred immediately after operation. The postmortem examination showed metastases to the lungs and the liver.

CASE 3. From the Surgical Clinic of Bern: Female, aged 41 years; had had a thyroidectomy 12 years ago, for a large growth. Recurrence had taken place, with rapid growth in the preceding 9 months. Tumor measured 12 by 8.5 by 10 centimeters and was adherent to the trachea. The patient died and the postmortem examination showed pulmonary metastases.

CASE 4. From Professor Kocher: Female, aged 49 years; had a rapidly growing tumor. No further clinical details were given.

CASE 5. From Professor Kocher: Male, aged 32 years. Two surgical specimens were obtained: one egg-sized; one 6 centimeters in diameter. No clinical details were given.

Lobenhoffer, in 1909, while discussing thyroid secretion, refers to 2 cases, abstracted below, which also fit into the category we are describing.

CASE 6. Female, aged 12 years, had a goiter which had grown rapidly in the preceding 6 months. Marked pressure symptoms were present. A resection of the left lobe and isthmus was performed. A small alveolar large cell struma of Langhans was demonstrated microscopically, all gradations being seen between small finely granular acidophilic cells and large coarsely granular cells. The case was considered benign.

CASE 7. A 40 year old woman was operated upon for goiter. No clinical data were submitted. The specimen presented the typical microscopic picture, and was considered benign.

Wegelin, in his monograph on the thyroid in Henke and Lubarsh's *Handbuch*, states

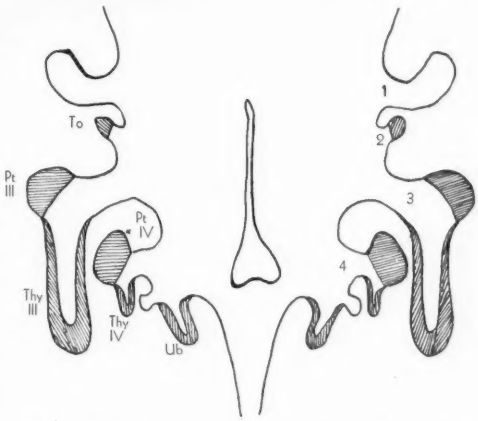


Fig. 1. Diagrammatic representation of the development of the thyroid, parathyroid, and thymus glands. *To*, the tonsil. *Pt*, the parathyroids, *I*, *II*, *III*, and *IV*. *Thy*, the thymus, *I*, *II*, *III*, and *IV*. *Ub*, the ultimobranchial body, *1*, *2*, *3*, and *4*, the branchial pouches. (From E. V. Cowdry, *Special Cytology:* after O. Grosser in Keibel and Mall, *Human Embryology*, 1912, 2: 461.)

that he has seen several such tumors in all age groups but that they were all benign. He submits no further clinical data.

Ewing, in his book on neoplastic diseases, also makes passing reference to what he calls "struma postbranchialis (Getzowa) or small alveolar large cell adenocarcinoma (Langhans)" stating that he has examined two tumors answering to that description, but he likewise submits no clinical data and does not indicate whether they were benign or malignant.

Haagensen describes 2 cases of thyroid carcinoma of the "small alveolar, large cell (Hurthle cell)" type. These reports, which are fairly complete, are as follows:

CASE 8. Female, aged 37 years. In 1918 patient had an enlargement of the thyroid associated with nervousness and menorrhagia. In 1924 a partial thyroidectomy was performed. The tumor measured 8 by 5 centimeters and there was perforation of the capsule. "Patient referred to Memorial Hospital with considerable tumor remaining." Three half erythema doses of x-ray (low voltage) were given between October, 1924, and January, 1925. The tumor slowly decreased in size. In October, 1930, the tumor was about the same. Pathology: thyroid small alveolar, large-cell (Hurthle cell) carcinoma, Grade II.

CASE 9. Female, aged 58 years. In 1906 following childbirth a goiter was noted which increased in size slowly. In December, 1915, the tumor was removed. The specimen was 11 by 8 by 5 centimeters, was encapsulated, and it was thought to have been completely removed. In 1924, there was a small recurrence which was treated with radon implantation in July, 1925. In January, 1926, cough and hemoptysis occurred, and the patient was admitted to the Memorial Hospital. An 8 by 6 centimeter hard, irregular mass was present at the base of the neck with pulmonary metastases and widening of the superior mediastinum. Improvement occurred for 2 months following high voltage x-ray therapy. The cough and hemoptysis ceased after 1 month, and the pulmonary metastases decreased in size.

In 1927–1928, 4 additional x-ray treatments were given. The condition remained unchanged. In July, 1929, the cough reappeared and the thyroid mass increased in size in spite of continued x-ray therapy. In October, 1929, there was back pain; x-ray examination showed metastases in the spine; additional x-ray therapy was given and a brace was applied. In 1930 x-ray therapy was continued. In 1931 the patient weakened considerably; the cough persisted. The neck and pulmonary recurrence remained unchanged, but the vertebral metastases increased. Pathology: thyroid small alveolar, large cell (Hurthle cell) carcinoma, Grade II. Large cuboidal cells with an acidophil cytoplasm and with small nuclei form compact, small, irregular alveoli.

Eisenberg and Wallerstein report a single case of Hurthle cell adenoma which was unusual in that it was associated with a toxic goiter.

CASE 10. A woman, aged 54 years, had a swelling of the neck for "years." It had grown appreciably larger in the preceding 5 months during which time she had three "spells of unconsciousness" each lasting 1 hour. The spells were accompanied by diffuse muscular twitching. Only slow loss of weight occurred in the preceding 5 months with cardiac palpitation on exertion and excitement. No nervousness or perspiration were noted. Menses were normal. The thyroid examination showed diffuse enlargement of both lobes of the thyroid. The neck veins were distended. There were no eye signs and no tremors. The heart was slightly enlarged with a systolic murmur at the apex. A basal metabolic rate of +40 fell to +18 after lugolization. A right subtotal hemithyroidectomy was done. Ten months later the patient was readmitted with swelling of the left lobe and isthmus of the thyroid. The basal metabolic rate was +41. A left hemithyroidectomy was performed. The basal metabolic rate then fell to +3, and 4 months later to −18.

The microscopic picture showed many small alveoli, long strands of palisade-like cells and occasionally syncytium-like masses. Some alveoli contained a small amount of colloid. The cells were large, fat-free, either polyhedral or irregularly shaped. They were clearly outlined. The cytoplasm was oxyphilic and finely granular. The nuclei were eccentrically placed, small and vesicular, with nucleoli, and they were rich in chromatin. No mitotic figures were seen, though a few double nuclei were noted. In addition the picture of toxic, non-exophthalmic goiter was present, with many areas of lymphocytic infiltrations. The diagnosis was "toxic non-exophthalmic goiter and Hurthle cell adenoma of the thyroid gland."

Clute and Warren, in a review of 226 cases of thyroid cancer, found 1 case of adenocarcinoma of the Hurthle cell type, but they did not report any clinical data other than an excellent photomicrograph exhibiting the characteristic appearance of the tumor. They remark: "While admittedly the cells resemble the oxyphil cells of the parathyroid, they appear to us to resemble even more closely the acidophilic phase occasionally encountered in the thyroid epithelium itself."

Our experience[1] comprises the following two cases:

CASE 11. Bronx Hospital No. 38653. A housewife, 47 years of age, was admitted to the hospital with a history of generalized arthralgias for the preceding 4½ years and a recent history extending over a period of 6 months of cardiac palpitation, tremor, sweating, and loss of 40 pounds in weight. The physical examination revealed hypertrophic enlargement and restricted motion of all of the joints. There was a firm nodular enlargement of the right lobe of the thyroid gland. The blood Wassermann test was negative. The routine urine examination was also negative. The white blood count and differential count were normal. The vaginal and urethral spreads revealed no Gram negative diplococci. The basal metabolic rate was +2 per cent.

Following a brief period of lugolization, operation was performed. The tumor was found to involve the right lobe of the thyroid gland and was enucleated with such difficulty that a partial excision of the right lobe of the thyroid gland was necessitated together with the tumor.

The specimen was a reddish brown mass of tissue 3 by 2 centimeters in diameter with some evidence of a thin fibrous capsule about the tumor. Microscopic examination revealed adenomatoid areas in a lymphocytic stroma. There were small areas of adenoma malignum or early thyroid carcinoma. The outstanding feature, however, was the presence of

[1]The pathological examination and the report of the microscopical picture in both of our cases was made by Joseph Felsen of the Laboratory of the Bronx Hospital. We are indebted to him for his co-operation.

strands and alveoli with papillary overgrowth of Hurthle type oxyphilic cells of characteristic structure. The immediate postoperative course was uneventful and was followed by intensive radiotherapy with a radium collar.

Examination of the patient 3 years later revealed no recurrence of the tumor.

CASE 12. Bronx Hospital No. 66465. A housewife, 47 years of age, was admitted with a 2 year history of a slowly increasing swelling in the neck. This was accompanied by some increased nervousness and sweating but there were no cardiac palpitation, tremor, exophthalmos, loss of weight, or any other symptoms of hyperthyroidism; no pressure symptoms were manifested. The physical examination revealed a diffuse firm enlargement of the thyroid gland, particularly on the left side, where a bruit was heard. There was slight cardiac enlargement but no other signs of cardiac disturbance. The white blood count was 8,100; the polymorphonuclears, 80 per cent; lymphocytes, 18 per cent; and monocytes, 2 per cent. The routine urine examination was negative. The basal metabolic rate was +22 per cent. The uterus was moderately enlarged by the presence of a fibroid tumor.

Following a brief period of lugolization operation was performed and a large ovoid tumor of the left lobe of the thyroid was enucleated. The remainder of the left lobe of the thyroid was subtotally resected.

The tumor was 5 by 4 centimeters in diameter, brown, and fleshy in appearance. Microscopic examination revealed an area of compact cellular tissue characterized by cords and light foamy polyhedral acidophilic cells with small eccentric nuclei. The remainder of the thyroid gland exhibited areas of varying cellularity, colloid distention, and focal lymphoid infiltration.

The postoperative course was uneventful, and the patient has remained well to this date (8 months).

CLINICAL FACTS

A number of clinical facts have been extracted from this review of the available clinical records of the Hurthle cell type of tumor:

1. In only one of the recorded cases has there been any associated thyrotoxic phenomena. This was Eisenberg and Wallerstein's case. This is remarkable.

2. No case, except one of ours, has shown any association with joint or bone manifestations. In this case, the laboratory and clinical observations have shown no data which could either (a) associate the tumor with any parathyroid structure, or (b) give any inkling of any metabolic disturbance usually associated with parathyroid activity.

3. There is no evidence that the presence of the Hurthle cell type of tumor has been associated with any other ductless gland disturbances.

4. In the recorded cases 4 "benign" and 6 "malignant" forms of Hurthle cell tumor are described, no statement as to the malignancy or benignancy being made in the remaining cases.

5. In at least 1 case (one of ours) several types of tumor seem to be present.

CELL OF ORIGIN OF HURTHLE CELL TUMOR

As is seen from the preceding anatomical and microscopic descriptions many cells differing only very slightly morphologically exist from which the Hurthle tumor might originate. Difficulty is added by the confusing terminology and nomenclature; for instance, Hurthle cell tumor, Langhans wuchernde struma, Getzowa struma, etc., may or may not be the same entities.

In Langhans' original description of these tumors the cells making up the parenchyma are described as large polyhedral oxyphilic granular cells about 15 or 30 microns in diameter arranged in small alveoli or trabeculæ. The nuclei are eccentrically placed, about 6 to 8 microns in diameter, and contain a large amount of chromatin in clumps and threads with a prominent nucleolus. Langhans, as well as other observers, aptly noticed the resemblance of these cells to the parenchymatous cells of the liver and adrenal cortex. Of greatest possible significance, however, was the very close resemblance of the tumor cells to the oxyphilic cells of the parathyroid, a fact which lead a group of observers, notably Eisenberg and Wallerstein, to believe that the tumors are of parathyroid origin. The latter observers bolster up their anatomical data with clinical observations concerning the physiological effects of the tumor which they observed in their patient (*vide supra*).

Eisenberg and Wallerstein consider this as evidence of the presence of a functioning parathyroid tumor although data on the blood calcium or calcium metabolism are not

mentioned. At any rate, even if it were conceded that the Hurthle cell tumor which they removed was a functioning parathyroid tumor, one would expect the episodes of tetany to follow rather than to precede the resection of the tumor. Their view is not generally accepted, however, and the similarity to the parathyroid cells is considered by some to be probably purely coincidental.

Getzowa, on analogous grounds, has claimed that the Hurthle cell tumors arise from the ultimo-branchial bodies, a view which while held possible by Langhans, is considered unwarranted by Wegelin.

Other observers, noting the similarity of the cells to the large oxyphilic interfollicular cells described previously by Hurthle, Baber, Langendorff and others, have considered these cells the true anlagen of these tumors and have accordingly classified them as Hurthle cell tumors. Numerous studies of normal thyroid histology have resulted in conflicting opinions as to the nature of this cell, and indeed the existence of any type of interfollicular epithelium has been questioned by many observers. Maksimov and Bloom (13) did not find any interfollicular cells in wax plate reconstructions and therefore consider at least some of the so called interfollicular cell groups as tangentially cut follicular wall, a view also held by Rienhoff. Wilson, and Williamson and Pearse, in their careful researches on the minutiæ of thyroid structure, make no mention of interfollicular epithelium. Nonidez (17, 18, 19) and Raymond have described parafollicular cells in various laboratory animals as has Zechel (26, 27) who considers them as phases in arrangement of the thyroid parenchyma in the cyclic destruction and regeneration of the follicles. Further doubt is cast upon the anatomical identity of these cells by the fact that, although they are of characteristic appearance, all grades of transition have been found between them and the principal thyroid cells (Langendorff). Maksimov and Bloom (14) believe them in all probability to be dead or dying cells. Wegelin considers the oxyphilic cytoplasm and vesicular nuclei as evidences of degeneration as seen in an anemic infarct of the kidney; while Marine's opinion is that such changes represent a stage in the secretory cycle of the normal thyroid epithelial cell.

The evidence at hand then would seem to indicate a physiopathological rather than an anatomical basis for the appearance of the so called Hurthle cell in the normal thyroid. If this is true, then, the so called Hurthle cell is a phase of the thyroid epithelium and as such does not represent a distinct anatomical unit but rather a functional change, probably nutritive. A similar interpretation probably obtains in the tumors of this cell type. This is supported by the observations of Wegelin who on one occasion noted an area of "large cell adenoma" in the center of an otherwise more usual type of thyroid carcinoma with all stages of transition between the larger and smaller cell types. In another case he found scattered areas of large cell formation in an otherwise usual form of *wuchernde struma* while a metastasis which appeared in the forearm several months later exhibited almost exclusively small alveoli with large oxyphilic cells. Clute and Warren have also noted the similarity between these cells and certain involutionary changes following primary thyroid hyperplasia.

CLASSIFICATION OF HURTHLE CELL TUMOR

Because of all of these essentially anatomical and physiological facts, the classification of tumors of the thyroid in general, and of the Hurthle cell tumor in particular has always been a difficult and controvertible one; and the number of classifications of thyroid tumors is almost as great as the number of students of thyroid pathology. Langhans' classification, made in 1905, is based upon an experience of 36 cases, and is as follows:

1. Die wuchernde Struma (adenocarcinoma).
2. Karzinomatose Struma mit dem gwoehnlichen unregelmaessigen Bau der Krebse (ordinary form of carcinoma).
3. Metastassierende Kolloidstruma (metastasizing colloid goiter).
4. Parastruma, Tumor der Epithelkoerper oder Glycogen-haltige Struma (Kocher). (Tumors containing excessive amounts of glycogen.)
5. Papilloma.
6. Kankroid.
7. Kleinalveolare, grosszelligen Struma, vieleicht Struma postbranchialis (Getzowa). (Small alveolar, large cell tumors [Hurthle type?].)

The classification of Haagensen made in 1931 is made from the Memorial Hospital material, is based upon a series of 30 cases, and is as follows:

1. Adenocarcinoma.
2. Small round cell carcinoma.
3. Giant cell carcinoma.
4. Papillary cystadenocarcinoma.
5. Small alveolar, large cell carcinoma (Hurthle cell type); 2 cases, 6.6 per cent.

Perhaps the most inclusive classification is that suggested by Clute and Warren upon an experience of 226 cases.

	Cases
1. Adenoma with blood vessel involvement	99
2. Papillary adenocystoma	51
3. Adenocarcinoma (including Hurthle cell adenocarcinoma)	31
4. Fibrosarcoma	3
5. Epidermoid carcinoma	1
6. Giant cell cancer	11
7. Small cell cancer	30

While certain types of neoplasia appear in each classification, there is no unanimity of opinion as to the various forms of cancer which appear within the confines of the thyroid gland; nor, indeed, is there any uniformity of definition regarding the limits of malignancy as the tumors are histologically portrayed.

DISCUSSION

One can predict with a reasonable degree of accuracy the future clinical course of many types of carcinoma of the skin, oral mucous membrane, cervix uteri, and certain other tumors on the basis of their histological features. The prognostic and biological significance of, for example, frequent mitotic figures, anaplasia, invasion, staining qualities, cell arrangement, and other features of established value in general oncology are found notoriously inadequate in their application to thyroid tumors. This has lead to a great deal of confusion in terminology, which in turn reflects the fundamental confusion in the criteria for pathological classification. To this day there appears no universally accepted classification of thyroid tumors, and the literature is clogged with such ambiguous and noncommittal terms as "benign metastasizing adenoma," "fetal adenoma," "strumas" of various sorts, and "tumors" not definitely assigned to a benign or malignant category. The lack of a single *fundamentum divisionis* in the classification of thyroid tumors has resulted in the separation of groups of tumors on various bases with consequent overlapping of groups. This has been further complicated by the known wide range of cell morphology in the normal thyroid gland as a result of physiopharmacological changes. In any attempt at a classification of thyroid tumors prime emphasis should be laid upon the benignancy or malignancy of each tumor type. This is at times difficult to determine, but in the last analysis must conform with the clinical course of the disease. If a tumor produces distant metastases it is malignant no matter how benign its histological structure may appear according to our present methods of analysis. This separation into benign and malignant tumors is of greater biological significance than any superficial similarity of cell types in tumors which are in some cases benign and in others malignant. It is because of the difficulty, at times, in establishing a definitive diagnosis of thyroid carcinoma that one is tempted to discard the fundamental basis of dichotomous division into benign and malignant tumors and to classify several tumors together on the basis of a similar cell structure. It was in this way that the Hurthle cell tumor of the thyroid was first described.

In Langhans' cases the fragmentary published data indicates that although there were no microscopic evidences of malignancy in any of the tumors, not even the characteristic invasion of the blood vessels stressed by Graham, 2 of the patients presented metastases with subsequent death. There can be no question but that these 2 cases represented types of thyroid carcinoma. The 3 other cases may have been benign tumors.

We have studied our 2 cases of so called Hurthle cell tumor of the thyroid from this viewpoint and were able to demonstrate in one case that the tumor was accompanied by an area presenting the usual picture of thyroid carcinoma immediately adjacent to the distinctive Hurthle cell form (Fig. 1). We feel that there is no reason to believe that two separate tumors coexisted in the thyroid but

rather that the two portions of the tumor represent different phases of the same process, which, if carried to completion, might have left behind no clue as to the origin of the larger cell type. Stated in another way our interpretation would suppose that the original stimulus to neoplastic formation engendered a thyroid carcinoma; that, with the growth of this carcinoma, new reactive stimuli were effected in the surrounding tissue; that these reactive stimuli, possibly expressed through changes in the vascular supply to the tumor, in turn affected the tumor resulting in a conversion of the histological appearance from that of the more usual type of adenocarcinoma to the Hurthle cell type; that this conversion is a secondary change which may so involve the entire tumor as to leave behind no trace of the original cell type in some cases; and that this new cell type, now representative of the tumor, is not to be considered a distinct form of tumor any more than is the Hurthle cell in the normal thyroid to be considered a fixed anatomical component of the gland. Furthermore this secondary change to the Hurthle type of cell may occur in tumors which originally may have been either benign or malignant, but following the conversion to the Hurthle cell type this difference may no longer be discernible. Accordingly it is readily understood why tumors formerly grouped under the single heading of Hurthle cell tumors may include both benign and malignant types. It is therefore most urgent, wherever possible, to search the tumor carefully for remnants of the original unchanged tumor for a clue as to its real malignancy or benignancy. It is only in this way that we may be able to separate individual tumors with this deceptively characteristic histological appearance into their respective benign and malignant categories, which division is, from a clinical viewpoint, the most fundamentally important one in the classification of thyroid tumors.

What is the clinical meaning of this secondary change? We believe that the malignancy is not dependent upon the presence of the so called Hurthle cell, but rather on the malignancy of the underlying tumor upon which is superimposed another factor (possibly nutritive) which is responsible for the conversion of the tumor cells, already either benign or malignant, to the Hurthle form. That this change may modify some of the properties of the tumor we do not deny. If, as we believe, these cells represent a degenerative change, we can expect some decrease in rapidity of growth, and a slightly more favorable prognosis, a view supported by the relatively benign course of even malignant cases.

TREATMENT

In the present state of our knowledge, the primary treatment of these tumors is surgical eradication. It seems better to resect the entire lobe than to enucleate the tumor.

RADIATION THERAPY

Experience with radiation therapy is available in the records of Haagensen's 2 cases and in 1 of ours. Haagensen's cases have gone 7 and 11 years respectively since operation and, according to him, have been definitely benefited by x-ray therapy. In our case, in which a radium collar was applied, the effect so far must be correlated with the failure of any metastatic focus to make its appearance; however, it is much too soon for us to make any definite statement with regard to the permanent result. This experience would tend to indicate the great value of radiation therapy in all cases after the tumor has been surgically eradicated.

SUMMARY

1. The origin and significance of the Hurthle cell in normal and neoplastic thyroid tissue is indicated.

2. Two thyroid tumors with this distinctive cell are presented and the relationship to thyroid carcinoma demonstrated in one of them.

3. At the present state of our knowledge, therefore, we consider it advisable not to place too great an emphasis upon the significance of the so called Hurthle cell type of tumor but rather to separate this group into its component benign and malignant categories upon more fundamental criteria. We suggest that the term Hurthle cell tumor be

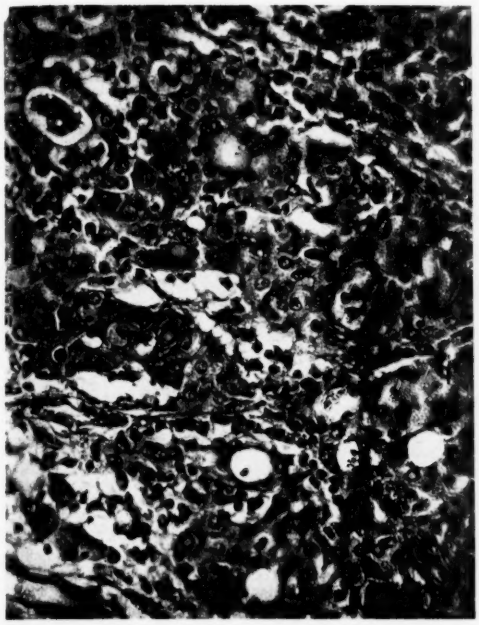


Fig. 2. Photomicrograph of section of tumor removed from our case, Case 11. Part of the tissue which might indicate malignant changes. ×45.

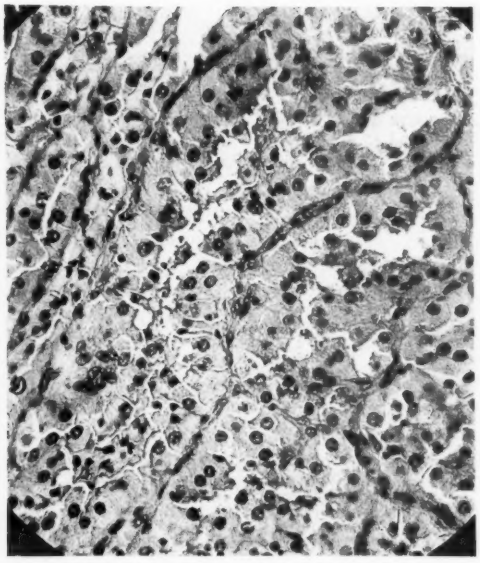


Fig. 3. In this photomicrograph which is from the same specimen as is Figure 2, is shown the typical Hurthle cell arrangement. ×75.

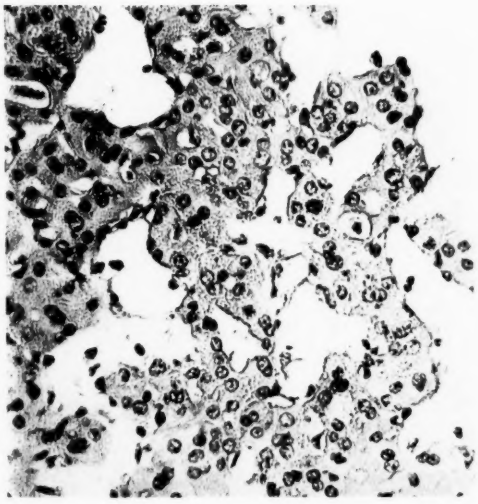


Fig. 4. Our case, Case 12, showing the typical characteristics of the Hurthle cell: large granular cells with large nuclei. ×75.

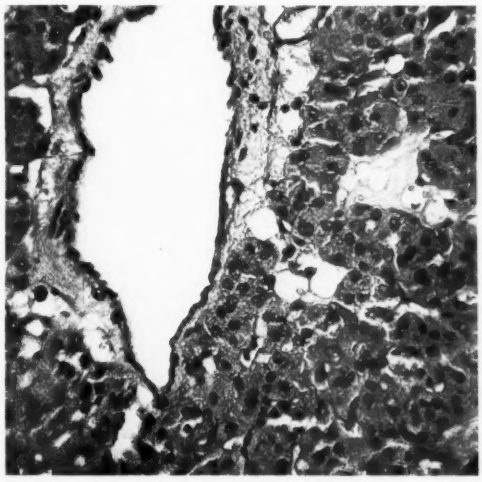


Fig. 5. From same specimen as is Figure 4. In this photomicrograph is shown the perivascular arrangement in the Hurthle cell tumor. ×75.

discarded and that it be replaced by the terms adenoma with Hurthle cell change and adenocarcinoma with Hurthle cell change.

BIBLIOGRAPHY

1. Baber, E. C. Phil. Tr. Lond., 1881, 209: 270.
2. Clute and Warren. The prognosis of thyroid cancer. Surg., Gynec. & Obst., 1935, 60: 861.
3. Eisenberg and Wallerstein. Hurthle cell tumor. Arch. Path., 1932, 13: 716.
4. Erdheim. Normal and pathological histology of the thyroid. Beitr. z. path. Anat. u. z. allg. Path., 1903, 33: 159.
5. Ewing. Neoplastic Diseases. 3d ed., pp. 952–954. Philadelphia: W. B. Saunders Co., 1928.
6. Getzowa, S. Ueber die Glandula parathyreoidea, intrathyreoideale Zellhaufen derselben und Reste des postbranchialen Koerpers. Arch. f. path. Anat., 1907, 188: 181.
7. Graham, A. Carcinoma of the thyroid. Surg., Gynec. & Obst., 1924, 39: 781.
8. Haagensen. Cancer of the thyroid: its radiosensitivity. Am. J. Cancer, 1931, 15: 2063.
9. Hurthle, K. Beitraege zur Kenntniss des Secretinsvorgangs in der Schilddruese. Arch. f. d. ges. Physiol., 1894, 56: 1.
10. Langendorff, O. Beitraege zur Kenntniss der Schilddruese. Arch. f. Anat. u. Physiol., 1889, Supp. Bd. p. 219.
11. Langhans, T. Ueber die epithelialen Formen der malignen Struma. Arch. f. path. Anat., 1907, 189: 69.
12. Lobenhoffer. Beitrage zur Lehre der Sekretion in der Struma. Mitt. a. d. Grenzgeb. d. Med. u. Chir., 1909, 20: 650.
13. Maksimov and Bloom. A Textbook of Histology. 2d ed., p. 305. Philadelphia: W. B. Saunders, 1934.
14. Ibid, p. 303.
15. Marine. The thyroid, parathyroids, and thymus. Cowdry's Special Cytology, vol. 1, p. 558. New York, 1928.
16. Miller. Normal and pathological histology of the thyroid. Beitr. z. path. Anat. u. z. allg. Path., 1896, 19: 127.
17. Nonidez. The origin of the "parafollicular" cell, a second epithelial component of the thyroid gland of the dog. Am. J. Anat., 1931–1932, 49: 479.
18. Idem. Further observations on the parafollicular cells of the mammalian thyroid. Anat. Record, 1932, 53: 339.
19. Idem. The "parenchymatous" cells of Baber, the "protoplasmareichen Zellen" of Hurthle, and the "parafollicular" cells of the mammalian thyroid. Anat. Record, 1933, 56: 131.
20. Raymond. Parafollicular cells in the thyroid of the rabbit. Anat. Record, 1932, 53: 355.
21. Rienhoff. In Practice of Surgery, edited by Dean Lewis. Vol. 6, Chap. I.
22. Russy and Clunet. Ann. de méd., 1910.
23. Wegelin, C. Schilddruese. In Henke, F., and Lubarsch, O. Handbuch der speziellen pathologischen Anatomie und Histologie. Berlin, 1926, vol. 8, pp. 191 and 252.
24. Williamson and Pearse. The structure of the thyroid organ in man. J. Path. & Bacteriol., 1923, 26: 459.
25. Wilson. The thyroid follicle in man: its normal and pathological configuration. Anat. Record, 1927–1928, 37: 31.
26. Zechel. Follicular destruction in the normal thyroid of the dog. Surg.. Gynec. & Obst., 1931, 52: 228.
27. Idem. Cellular studies of the thyroid gland. Surg., Gynec. & Obst., 1932, 54: 1.

CONGENITAL ANOMALIES OF THE RECTUM AND ANUS

J. K. BERMAN, M.D., F.A.C.S., Indianapolis, Indiana

SINCE congenital anomalies of the rectum and anus occur about once in 5,000 newly born babies (3), the average physician will not see a large number of cases. Statistics concerning the frequency of these lesions are extremely variable. Zohrer at the Vienna Lying-In Hospital and Collins in the Dublin Lying-In Hospital jointly report 66,654 deliveries with 3 cases of imperforate anus. These statistics are quoted in Ball's textbook, published in 1887 (1). The Riley Hospital receives children from all sections of the State of Indiana and in the last 12 years there were 34,454 admissions with 22 anomalies of the rectum and anus.[1]

The diagnosis of anomaly in this region is not difficult, especially in the serious cases which are associated with, and present symptoms of, acute intestinal obstruction. The difficulty arises in diagnosing the kind of anomaly present so that proper surgical approach may be made.

EMBRYOLOGY

The mesenteron or central portion of the alimentary canal is formed from the entoderm and consists at first of a simple tube which ends blindly anteriorly and posteriorly. This tube represents only the mucous membrane. Later it becomes enveloped in a layer of mesoderm which differentiates into two portions—the outer forming the peritoneal covering while the inner forms the muscle and connective tissue elements. An invagination of ectoderm takes place later at the two ends, anteriorly the stomodeum which constitutes the mouth and posteriorly the proctodeum which constitutes the anal orifice. If we briefly refer to the diagram (Fig. 1) we see that in the 5 weeks embryo the intestine and urogenital sinus empty into a common opening which is known as the cloaca. This condition is normally present in certain birds and in certain fowls. It is really a caudal expansion of the hind gut which gives off in front of the allantoic stalk (bladder).

At 6 weeks the saddle-like partition between the intestine and the allantois, and known as the urorectal septum, grows caudally, dividing the cloaca into a dorsal rectum and a ventral primitive urogenital sinus. This is complete at about 9 weeks. In the male this latter structure gives rise to the bladder and a greater portion of the urethra, all but the anterior part; and above and posteriorly it receives the mesonephric ducts which later become the vasa deferentia. In the female the muellerian ducts which are derivates of the aforementioned, later become the uterus and vagina.

The perineum develops by the division of the cloacal membrane into the urogenital membrane in front and the anal membrane behind and by a down growth and spreading out of the mesenchymal elements between these two membranes. At 6 weeks the coccygeal eminence is very prominent and in front of it is a slight elevation surrounded by a groove. From this will develop the anus and generative organs (Fig. 1). At 8 or 9 weeks the anus is separated from the cloacal opening and the perineal septum has begun to form. At 10 weeks determination of sex is possible and the anus is separated from the anterior perineum. This separation is so complete that extravasation of urine is limited to the front of this space and abscesses connected with the rectum seldom invade the front portion. A small pit forms in the perineum (proctodeum) which folds inward until it joins the hind gut. This infolding occurs when the membrane separating them and known as the anal membrane ruptures. This takes place about the eighth week of pregnancy and the point of junction corresponds to what is known as the white line of Hilton in the adult.

From the Surgical Service of the James Whitcomb Riley Hospital and the Department of Surgery, Indiana University School of Medicine, Indianapolis.

[1]The 23d case was in the Coleman Hospital.

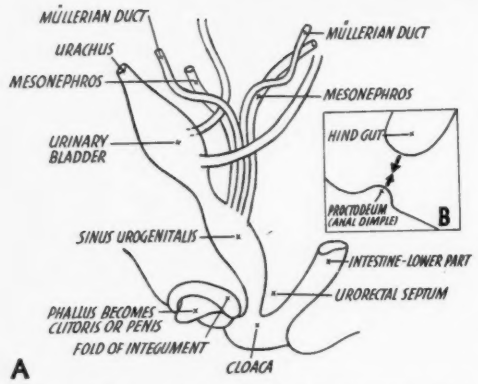


Fig. 1. Diagram of embryological development. Division of the rectum and urogenital diaphragm in the early embryo. Inset, method of inversion of proctodeum and descent of hind gut.

TYPES OF MALFORMATIONS

Most malformations are an arrested development or irregular growth of the proctodeum or the mesenteron. Frequently there is a failure of closure of the perineal septum and then the various forms of fistulas occur. It may readily be seen that anomalies may occur involving the rectum, the anus, the urogenital tract, or any combination of these structures. Many classifications have been advanced to cover all varieties of malformation. Perhaps the most complete and earliest of this group will be found in Ball's textbook:

1. Preternatural narrowing of the anus at the margin, occasionally extending some distance above this point.

2. Complete occlusion of anal aperture by simple membrane or common integument.

3. No anus whatever, the rectum being partially deficient and terminating in a cul-de-sac at a greater or less distance above its natural outlet.

4. The anus in this variety is normal, the rectum at a variable distance above it being either obstructed by a membrane or completely occluded for a greater or less distance.

5. The anus opens at some part of the perineal or sacral region, instead of at its normal position.

6. The rectum opens into the bladder, urethra, or vagina, sometimes forming a complete cloaca, the normal anus usually being absent.

7. Rectum normal, with the exception that either the ureters, the vagina, or uterus, open preternaturally into it.

8. The rectum is entirely wanting.

9. The rectum and colon both absent. In these cases there is sometimes an opening leading to the intestine at some other part of the surface of the body. It will be seen that in the first three varieties the development of the proctodeum is principally at fault, while in the others the malformation is of a more complicated character.

Fig. 2. Left, four types of anomalies which have been encountered.

Center, types of fistulas in male: (A) rectovesical, (B) recto-urethral, (C) rectoperineal.

Right, types of fistulas in female: (A) rectovesical, (B) rectovaginal, (C) rectofossa navicularis and rectofourchette, (D) rectoperineal. (Modified from Ladd and Gross, loc. cit.)

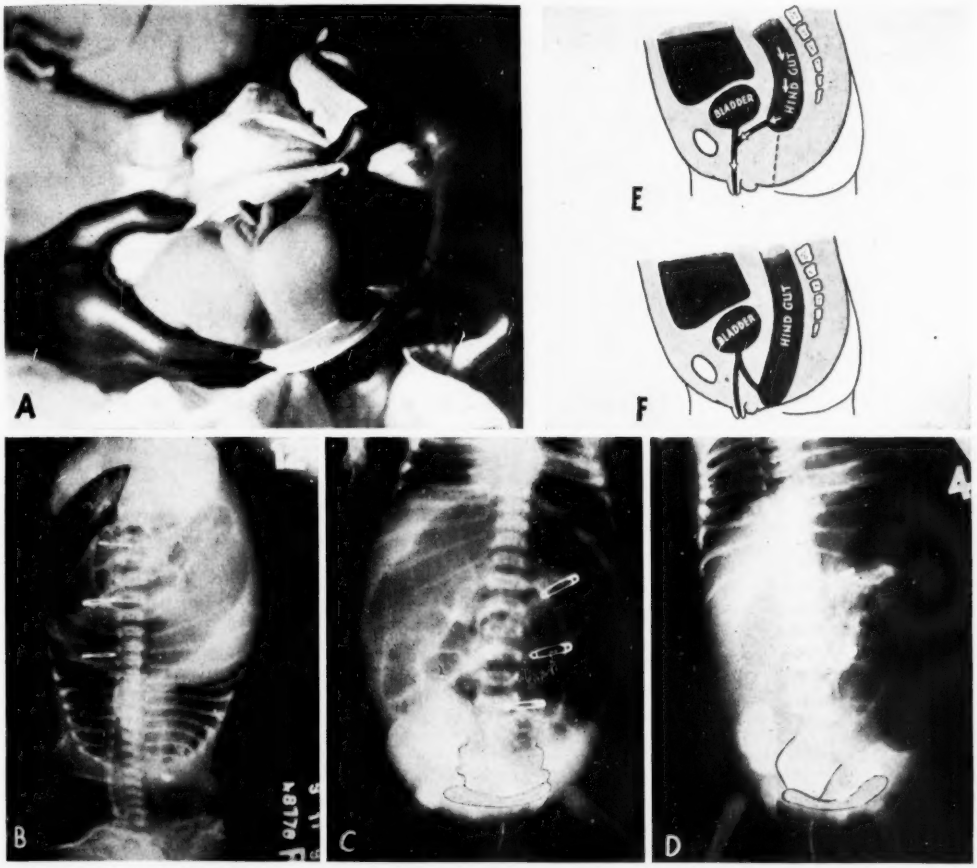


Fig. 3. A, Clinical appearance of perineum. Note absence of anus and incomplete development of genitalia. B, Roentgenogram, retouched, showing upside down position. After massage under fluoroscope air pocket was found to descend to a lower level. C, Injection of sodium iodide into bladder. Note its unusual shape and the abnormal ureters. D, Injection of sodium iodide through recto-urethral fistula into hind gut. E and F, Diagram of recto-urethral fistula before and after operation. Case R-18960. S. S.

According to Fraser the congenital malformations of the anus are as follows:

1. Congenital narrowing of the anal canal.
2. Congenital occlusion of the anal canal, by fibrous or membranous tissue, the occlusion being partial or complete.
3. Abnormal location of the anus.
4. Congenital absence of the anus.

Whereas the congenital malformations of the rectum are:

1. Total absence of rectum.
2. Atresia of the lower end of the rectum.
3. Membranous occlusion of the rectum.
4. Rectovaginal, recto-urethral and recto-vesical fistulas. This classification is accurate anatomically, but does not lend itself well to clinical application because combinations are the rule. A better grouping for practical purposes is the one suggested by Ladd and Gross which is as follows (Fig. 2):

1. Incomplete rupture of the anal membrane or stenosis at a point 1 to 4 centimeters above the anus. Repeated rectal dilatations is all that is necessary.

A

B

C

Fig. 4. A, Before operation. Note enormous distention. B, After operation. C, Diagram indicating anomaly encountered. Rectovaginal fistula running between septum in double vagina. Case R-15694. A. H. K.

2. Imperforate anus or obstruction due only to a persistent membrane. Cruciate incisions followed by dilatations is all that is necessary.

3. Imperforate anus with rectal pouch separate from anal membrane. (Most frequently encountered anomaly.) Perineal incision is required and rectal pouch should be brought down to anal sphincter.

4. Anus and anal pouch normal, but rectal pouch ending blindly. Most difficult to treat because the rectal pouch is so high that it is difficult to reach through perineal approach; mortality, 61.6 per cent.

If now we add to this classification the various types of fistulas we have a satisfactory clinical grouping. By referring to the embryological review we may readily understand why in the male there may be rectovesical, rectourethral, or rectoperineal fistulas, whereas in the female there may be rectovesical, but more commonly rectovaginal or rectovulvar or rectoperineal fistulas (Fig. 2).

CAUSE OF ANOMALIES

The cause of these anomalies is, of course, a matter of conjecture. Some say it is apt to occur in families (6). Others have said fetal peritonitis or chorionic adhesions as well as

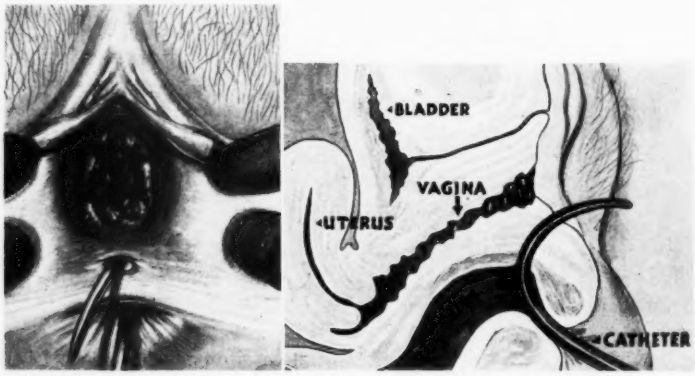


Fig. 5. A, Diagram showing rectoperineal fistula. Sphincteric action present in both openings. B, Diagram of cross section.

fetal enteritis (4) may be the cause. One thing is definitely known—that these anomalies usually do not occur singly and this must be borne in mind in prognosis and treatment.

SYMPTOMS OF ANOMALIES

The symptoms of most of these patients are those of acute intestinal obstruction. Sometimes there is partial intestinal obstruction with distention and in the fistulous types parents will note that there is an abnormal opening with an absence or occlusion of the anus. Further discussion is unnecessary for diagnosis is made easily when the possibility of these congenital anomalies is considered.

DIAGNOSIS OF TYPES

The chief concern of the surgeon is the accurate diagnosis of the type anomaly that exists. In order to establish this many methods are used, such as:

1. X-ray examination of the abdomen with the child in the upside down position (9). The rationale for this is the hope that gas in the obstructed hind gut will rise to the top or dome of the obstruction, thereby revealing its proximity to the anal canal. This method is a very useful one, but leads to errors in diagnosis during the first 24 hours of life because gas is rarely present beyond the hepatic flexure (Fig. 3).

Fig. 6. A, Photograph of anomaly present. Note the rectofossa navicularis fistula (retouched). B, After operation. Note double vagina and reconstructed perineum. Case C-R-5583. J. R.

2. Injection of 12½ per cent sodium iodide when there is an external fistula (Fig. 3); this should be done also to reveal internal fistulas.

3. Performance of a colostomy with digital examination of the blind hind gut. This method is fraught with danger because the mortality in this group is extremely high (some figures up to 90 per cent).

4. We have recently used the fluoroscope as an aid in diagnosis, especially in the first

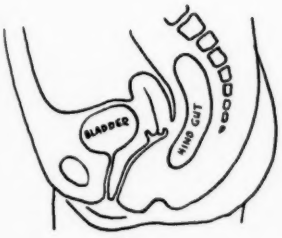


Fig. 7.

Fig. 8.

Fig. 9.

Fig. 7. Diagram of imperforate anus, group IV. Case R-12224. V. G.

Fig. 8. Photograph of rectofourchette fistula before operation. Case R-2736. N. S.

Fig. 9. Photograph of rectoperineal fistula. Note persistency of genital tubercles or swellings. Case R-19119. G. R.

Fig. 10. Diagram illustrating stones in the neck of the bladder and rectovesical fistula with diverticulum containing a urinary calculus. Case R-1878. D. D.

24 hours of life. The infant may be moved in various positions and by gentle massage of the abdomen gas is forced down or up into the blind hind gut. The position is then marked by bony landmarks or by metal arrows fastened to the skin by adhesive. Thus far we have had no inaccurate diagnosis by this method.[1] The fluoroscope often reveals co-existent anomalies by demonstrating pockets of gas which cannot be shifted from one portion of the intestine to another.

TREATMENT

Treatment obviously varies with the type anomaly and the age of the child. We may dogmatically state the following rules concerning treatment:

1. All treatment depends upon accurate diagnosis.

2. Avoid colostomy whenever possible. Mortality in this group is high, especially in the newborn.

3. Dissections should be made from below by making a longitudinal incision from the middle of the perineal body posteriorly to the coccyx, thereby cutting directly through the sphincter. Since the external anal sphincter muscle develops from regional mesenchyma and is not dependent upon the presence of the terminal bowel it is practically always present. This accounts for good sphincteric control in patients operated upon for congenital absence of anus. The rectum descends in the hollow of the sacrum closely applied to that bone and except at its upper part is uncovered by perineum posteriorly. In front the perineal pouch descends to a much lower level, while its close relations to the genitourinary organs should be borne in mind. Dissection should then be carried upward hugging the coccyx and the hollow of the sacrum, staying in the midline. Extreme gentleness and care are necessary until a structure resembling membrane is encountered; since this may be peritoneum it should be gently pushed back anteriorly. The operation is carried on under local anesthesia in the newborn, and as the baby cries and strains the hind gut is seen to bulge into the field of operation. After mobilization is complete the hind gut is

[1]The author is indebted to Dr. Wright, of our x-ray department, for his aid in developing this procedure.

Fig. 11. Left and center, infant 6 weeks old with rectofourchette fistula before operation. Right, case of rectofossa navicularis fistula in an infant 3 months of age, 5 weeks after perineal operation.

TABLE I.—ASSOCIATED ANOMALIES

Heart	
Patent ductus arteriosus	2
Patent foramen ovale	1
Congenital heart lesion, type not classified	1
Arteries	
Congenital atresia of right iliac	1
Lungs	
Congenital atelectasis, left lung	1
Genito-urinary tract	
Double vagina	2
Cryptorchidism	1
Anomaly of bladder and ureter	2
Absence of the left kidney	1
Gastro-intestinal tract	
Meckel's diverticulum	1
Congenital malformation of ileum	1
Abdominal wall	
Umbilical hernia	2
Feet	
Bilateral club feet	1
Brain	
Mongolian idiocy	1
Spine	
Spina bifida occulta	1
Congenital partial absence of lumbar vertebra	1
Eyes	
Strabismus	1
2 children had 2 anomalies each.	
2 children had 4 anomalies each.	
The 9 remaining children had 1 anomaly each.	
Total cases having anomalies (56.5%)	13

TABLE II.—TREATMENT AND RESULTS

Medical

Group	Results			
	Recovered	Died	Improved	Unimproved
I—1		1		
II				
III				
IV—1		1		
V—3		1		2
Total—5		3		2

Surgical

Group	Results			
	Recovered	Died	Improved	Unimproved
I—1	1			
II—2	1	1		
III—2			2 (Colostomy)	
IV—2	1	1		
V—11	10	1		
Total—18	13	3	2	

Deaths in hospital (medical and surgical)	6
Deaths after leaving hospital (medical and surgical)	5
Total deaths (medical and surgical)	11

brought down to the skin, a hollow needle is inserted to make sure of the structure and then a cross incision is made and the mucous membrane sewed to the skin in a position corresponding approximately to the anal sphincter. Chromic catgut No. 0 is used to suture the bowel to the skin as well as to close the incision.

4. If a fistula is present, it should be left alone until the child is older. This is done because attempts to close them at the time of operation fails in half the cases and increases the mortality. In older children fistulas may be closed if accessible, but if in the bladder closure should be deferred until the child is much older; also, fistulas sometimes, although very rarely, will close spontaneously after the rectal opening is re-established. If the child is unable to stand any surgery, then simple dilatation of the fistula may be used temporarily.

SUMMARY OF CASES

Of the 23 cases, there were 12 males and 11 females. One of doubtful sex (Fig. 3) was thought to be a female, but diagnosed a male because of structures which felt like testes in the genital folds and a urethra which traversed the genital tubercle. So far as I am able to ascertain the urethra has never been reported in the clitoris.

Six were in the newborn, 10 under 1 year, 4 between the ages of 1 and 5 years, and 3 over 5 years of age.

Fourteen had associated fistulas, 9 did not. Following our grouping there were 2 in group 1; 2 in group 2; 2 in group 3; 3 in group 4, and 14 (60 per cent) in group 5.

Thirteen (56.5 per cent) of these patients had associated anomalies. Two of these had four present. Nature does not err singly in most cases (Table I).

Five patients were treated by palliation or were *in extremis* before surgical treatment could be instituted. Of this group 3 died and 2 were unimproved, a mortality of 60 per cent.

Eighteen were treated surgically. There were 3 deaths in this group and an operative mortality of 6.6 per cent. A follow-up study

of these cases showed that 5 others had died since their release from the hospital.

This brings the total deaths to 11 or 47.8 per cent over a period of 12 years (Table II). In 8 (72.8 per cent) of these deaths associated anomalies were present which accounted for their demise.

GROUP I

Ball: Preternatural narrowing of anus at margin occasionally extending some distance above this point.

Ladd and Gross: Incomplete rupture of anal membrane or stenosis at a point 1 to 4 centimeters above the anus.

R-5383, L. G., male, aged 4 years; full-term baby. At 1 month his weight was 6 pounds. The child had attacks of colic, which persisted as severe abdominal cramp-like pains. He had infantile paralysis at 2½ years of age. There was no control of bowel action. Diagnosis of Hirschsprung's disease was made elsewhere. Our examination showed a constriction of the anus about ⅜ inch above the external sphincter. This was hard and unyielding, with fecal impaction above. On October 3, 1933, the stricture was divided by cautery and followed by repeated dilatations. Last seen on May 27, 1935, when anus was open and there was no fecal impaction. The mother was instructed to continue dilatation.

R-9494, R. D. D., male, aged 2 months; full-term, normal delivery; birth weight 8¼ pounds. At 3 weeks of age he had projectile vomiting. He was given a formula and atropine which helped some, but he lost weight. He was admitted to Riley Hospital on August 29, 1934, with diagnosis of imperforate anus (group I), bilateral club feet, and deformity of the back. Treatment was symptomatic and supportive, but his condition became progressively worse and he died on September 16, 1934. Postmortem examination disclosed congenital partial absence of vertebræ, talipes equino varus, imperforate anus, absence of left kidney, acute suppurative otitis media, acute mastoiditis, infectional gastro-enteritis, and Bacillus coli septicemia.

GROUP II

Ball: Complete occlusion of the anal aperture by simple membrane or by common integument.

Ladd and Gross: Imperforate anus or obstruction due only to persistent membrane.

R-7915, B. J. H., male, aged 17 months; full-term baby. An imperforate anus was discovered at birth. The anal membrane was opened and the stricture was dilated on four occasions. On January 15, 1934, a peri-rectal abscess was drained which left a fistula-in-ano. No further surgery was done and no further symptoms were reported. On March 19, 1934, the child was readmitted to the hospital with the diagnosis of achronic otitis media and mastoiditis. A mastoidectomy was done. Child died April 8, 1934, of infectious diarrhea. No associated anomalies.

R-13595, C. L., female, aged 3 days; premature birth. Soon after birth the physician noted an imperforate anus with marked distention. Upon admission to the Riley Hospital on July 24, 1935, the distention was very marked and the child was not voiding. She was vomiting and her condition was very critical. She was placed in the oxygen chamber and was given fluids subcutaneously. A small incision was made through the anus and a large quantity of gas escaped through the tube. No further operative procedure was done because of the critical condition of the patient. She died on July 25, 1935. No postmortem examination was made. Associated anomalies were in the urinary tract.

GROUP III

Ball: No anus whatever, the rectum being partially deficient and terminating in a cul-de-sac at a greater or less distance above its normal outlet.

Ladd and Gross: Imperforate anus with rectal pouch separate from anal membrane.

R-10895, L. A., male, aged 17 months; full-term baby; birth weight 8¾ pounds. Forty-eight hours after birth it was noted that there was a congenital absence of the anus. The child was taken to the hospital immediately (elsewhere) and operated upon. Colostomy was performed and following surgery the child improved. He was admitted to the Riley Hospital on October 3, 1934. Diagnosis of imperforate anus was made. X-ray examination with barium showed good filling of the large intestines to the level of the colostomy, but no barium went below this area. X-ray did not demonstrate a sigmoid or rectum near the normal location. The child was sent home on October 31, 1934, and was readmitted on April 23, 1935, for surgery, but this procedure was not done because the ward was isolated for scarlet fever. He was furloughed on May 8, 1935, to return in 3 weeks. However, he was not brought back at that time. Associated anomalies: none.

R-13986, J. W., male, aged 3 months; full-term infant; weight 8 pounds, 11 ounces; breech extraction. At birth the physician noted that there was a congenital absence of the anus. The baby was operated upon July 6, elsewhere, and a colostomy was done. He was admitted to the Riley Hospital on September 14, 1931. Upon admission the child was markedly dehydrated and the only treatment was repeated blood transfusions which were unavailing. The child died on September 23, 1931. Diagnosis: imperforate anus with rectal pouch separate from the anal membrane. Associated anomalies: patent ductus arteriosus.

R-5149, D. L. D., male, aged 2 days; full-term child; breech delivery; birth weight 7½ pounds. The parents noted that the baby had no bowel movements and that he vomited. Physician made diagnosis of imperforate anus and the child was admitted to Riley Hospital on January 24, 1933. He was operated upon immediately. Skin incision was made through the approximate site of the anus. Tissues were dissected back, and the sac of the hind gut was exposed. This was opened and sutured to the skin margins forming an anus. Much meconium was passed. The infant did well for a period of 4 days after operation when he suddenly became cyanotic and physical and x-ray examination definitely determined that there was a partial collapse of the left lung field, diagnosed as atelectasis neonatorum. Oxygen therapy was instituted; however the patient died on January 31, 1933. Postmortem examination disclosed imperforate anus, Meckel's diverticulum, and atelectasis of left lung.

GROUP IV

Ball: Anus normal, rectum at a variable distance above obstructed by membrane or completely occluded for a greater or less distance.

Ladd and Gross: Anus and anal pouch normal. Rectal pouch ending blindly.

R-12224, J. G., female, aged 2 days; normal delivery; full-term baby; birth weight 8 pounds. Mother noticed that the patient did not have a bowel movement and the physician made the diagnosis of imperforate anus and referred the child to the Riley Hospital. Admission was February 17, 1935. A dimple was found about the region of the anal orifice and a slight protrusion was noticed when the baby cried. Incision was made in this area and with blunt dissection the subcutaneous tissue was pushed back with a hemostat until the hind gut was reached which was approximately 2 centimeters from the skin. The hind gut was opened at which time a large amount of gas and meconium was expelled. The hind gut was loosened and pulled down with four clamps. It was then sutured to the skin with interrupted plain catgut No. 1 sutures. No anesthesia was used and the patient was in good condition following operation. On April 13, 1935, patient was readmitted. Diagnosis of scar tissue contracture resulting in imperforate anus was made. After repeated dilatations the patient was discharged on April 13, 1935, in an improved condition. Associated anomalies: mongolian idiocy. (See Fig. 7.)

R-16305, M. E. J., male, aged 2 days; admitted May 20, 1936. Shortly after birth, which was a breech presentation, the child began to vomit. Vomiting was projectile in type and sterocoraceous in character. There had been no stools. The baby was cyanotic and the abdomen markedly distended. A slight anal dimple was found, but there was complete atresia of the rectum. X-ray examination showed the hind gut to be a short distance above the occluded anus. The child was immediately transfused; he received 70 cubic centimeters of citrated blood. However, before the child could be prepared for surgery, he died and an autopsy was obtained. This revealed a congenital atresia of the anus and descending colon at the rectosigmoid junction, and an occlusion of the hind gut. Associated anomalies: patent ductus arteriosus; patent foramen ovale; cryptorchidism, bilateral.

GROUP V

Ball: Rectum opens into bladder, urethra or vagina sometimes forming a complete cloaca, the normal anus usually being absent, or

Author: Fistulas in combination with any of previous groups. Most common type of anomaly in our series.

R-6441, M. P., male, aged 10 years, premature child 8 months; weight 5 pounds. Diagnosis of imperforate anus made at birth and perineal operation performed at 30 hours bringing hind gut down to anal orifice with recovery. Child's mother noticed bluish discoloration of the nails at 5 weeks and a congenital heart lesion was demonstrated at this time. At 6 months feces was seen to come through penis. Child was next seen at the age of 4, and a definite rectovesical fistula was demonstrated. Now at the age of 10 sphincteric control is present although not strong. Urine occasionally is loaded with pus and Bacillus coli demonstrated but soon cleared up after bladder irrigations. Congenital heart lesion present; since bladder condition was controllable, no further surgery was done. Child has been a cardiac invalid. Last seen April 17, 1937.

R-1878, D. D., aged 2 years, male; was born without anal opening. At 26 days a perineal operation was done elsewhere and the rectum brought down to the skin. At 1 year of age a colostomy was attempted elsewhere. However, the small bowel was entered and an enterostomy was performed instead. This soon closed. On admission to the Riley Hospital on April 19, 1932, the child was found to have a small anal opening with no sphincteric control, and in addition a rectovesical fistula. The urine was contaminated with fecal matter. Cystoscopic examination was done on May 26, 1932, and kidney, ureter, bladder plate showed the presence of multiple calculi in the urinary bladder. Intravenous pyelogram revealed dilatation of the right ureter and apparently no functioning of the left kidney. X-ray plates of the lumbosacral spine showed a spina bifida occulta of the first two sacral segments. Retrograde cystogram disclosed a definite fistulous tract between the bladder and the rectum. Surgery on June 23, 1932, was as follows: "Midline incision extending from pubis well up toward the umbilicus. Fascia divided and bladder exposed by blunt finger

dissection. Bladder opened and two stones removed from the posterior urethra. A third stone was not found in the bladder. It was located outside of the bladder cavity. Its size was approximately 1 by ¾ inch, freely movable, and could be felt from within the bladder wall on any side and could be brought down to neck of the bladder. It was smooth and flat on one side. The bladder was freed on the left, but the stone was not attached in this region. On rectal examination the stone could also be felt outside the gut and outside the bladder. The bladder was anchored to the abdomen with silk, a piece of gauze was inserted above and below and a Pezzer syphon tube was anchored in the bladder. The skin was closed with silk worm gut. Patient left the operating room in good condition. Proctoscopic examination revealed a small fistulous tract about 1 inch above the strictured area in the rectum. The stricture was dilated and the child was dismissed on August 19, 1932, to return for future dilatations. It was felt that the child would not be benefited by surgical closure of the fistulous tract at this time. Follow-up disclosed that the child died in 1937. An autopsy revealed congenital atresia of the rectum, rectovesical fistula, and a stone in a diverticulum of the fistulous tract (Fig. 10).

RECTOVAGINAL FISTULA

R-15694, A. H. K., female, aged 7 weeks; full-term baby of syphilitic mother—three siblings (2 stillborn, 1 died at 1 week), 1 miscarriage. When 7 weeks old there was an enormous abdominal distention, general emaciation, but no vomiting. Diagnosis: imperforate anus, rectovaginal fistula. Operation was done March 18, 1936. Hind gut was brought down to the skin through a perineal incision after perineum was divided. Double vagina was divided and the perineum reconstructed. Recovery followed operation. Repeated dilatations were done. Last seen November 22, 1936. Good progress had been made. On December 13, 1936, seen by Dr. K., of Laporte, when there was obstruction due to intussusception at the iliocecal valve. Baby died before surgery could be instituted (Fig. 4).

R-15071, J. A. G., female, aged 6 weeks; slightly premature, normal delivery; birth weight 6½ pounds. On the day after birth it was noted that the bowel movement was through the vagina. An anal dimple was present, but there was no opening. Baby was in good nutritional state upon admission on December 17, 1935. Diagnosis was imperforate anus and congenital rectovaginal fistula. No surgery was attempted because of the infant's poor condition and treatment was supportive and symptomatic. Patient gradually grew worse, and died on April 10, 1936. Postmortem examination showed bronchopneumonia, otitis media, congenital imperforate anus, and rectovaginal fistula.

R-1662, M. A., female, aged 4 months; born August 20, 1930, full-term, normal delivery. On the second day after birth the mother noticed that the child had had no bowel movement and examination of the perineum revealed that no anus was present. A small amount of fecal matter was coming through the vagina. The family doctor then dilated the rectovaginal fistula and the baby managed to thrive with the condition until admission to the Riley Hospital on December 14, 1930. Diagnosis in the hospital was rectovaginal fistula with congenital absence of anus. On April 15, 1931, under ether anesthesia, perineal incision was made, the vaginal canal and bowel opening identified, and the rectum dissected away from the vaginal floor. A muscular band was found just below the fourchet which had the resemblance of sphincter fibers. With blunt dissection an opening at the approximate site of the anus was made and the rectum brought down through this and sutured to the cutaneous margin with plain catgut No. 0. The skin incision and lower part of the vaginal floor were closed with interrupted sutures of plain catgut No. 0. Following this operation the sutures pulled out and a second operation was done on April 21, 1931. Rectum was again brought down to the new opening made at the first operation and anchored with continuous sutures of black silk, interrupted at three places. Vaginal mucosa was anchored at the cutaneous margin with interrupted sutures of plain catgut No. 0. Following this procedure repeated rectal dilatations were done. The patient was discharged on June 12, 1931, and was last seen on June 25, 1934, with marked improvement. No associated anomalies were recorded.

R-5242, M. McC., female, aged 7 months, normal delivery. Shortly after birth attending physician noted the absence of an anus and that fecal matter was exuding from the vagina. The patient seemed to thrive in spite of this anomaly until February 4, 1933, when she was admitted to the Riley Hospital, because of distention. Our diagnosis was congenital narrowing of the anus with rectovaginal fistula. Repeated dilatations were done and the patient made a satisfactory recovery. Last seen in the out-patient department on February 17, 1936, with satisfactory progress noted.

R-3156, G. C., female, aged 7 months; full-term, normal delivery. At birth physician noted that the anus was imperforate and that fecal matter exuded from the vagina. The fistulous tract was dilated and the child seemed to thrive until her admission to the Riley Hospital on April 25, 1937, with bronchopneumonia. No operative procedure was done except for dilatation of the rectovaginal fistula. The parents were asked to return the child for surgery at a later date, but this has not been done; therefore the present status of the child is unknown. A letter received November 8, 1927, reported that she had been feeling well and was gaining weight, and that the family had moved to Illinois.

RECTOVAGINAL AND RECTO-URETHRAL FISTULA

R-15092, J. M. S., female, aged 6 months; full-term baby. No abnormality was noted by physician at birth. When 8 days old mother noted bowel ac-

tion through vagina and absence of anus. Insertion of two opaque catheters and injection of opaque media showed the posterior catheter to lead into the rectum and the anterior catheter into a small bladder. There was then a recto-urethral as well as recto-vaginal fistula, but the latter was much larger and all fecal matter discharged through it. No treatment was done by staff at this time. A small umbilical hernia was present. Last seen April 27, 1936, in good condition.

RECTOVAGINAL AND RECTOPERINEAL FISTULA

C-8656, S. U., female, aged 19 years. Patient was seen in Prenatal Clinic at the Coleman Hospital where general physical examination had failed to disclose the congenital malformation of the rectum. She was admitted to the hospital on December 21, 1935, in labor. On admission it was noted that rectal examination was impossible because the rectal opening was too small to admit a finger. She was allowed to continue in labor, and after 15 hours the head was no farther than mid-pelvis by abdominal examination. Vaginal examination was therefore done and disclosed that the middle finger accidently entered an unseen opening and the index finger entered the vagina. Closer examination revealed this opening to be about midway between the hymenal ring and the true anus, and easily admitted a finger. There was a moderate degree of sphincter action about this opening. Previous to this nurses had reported that rectal ether, which had been given through a catheter into the rectum through the anus, had come out of the vagina. The anomalous opening was invisible to ordinary examination due to the peculiar way in which the mucous membrane was overlapped and folded. Further history at this time revealed that the patient had been born with a very small anal opening. At 1 year of age excision of the fistula was attempted elsewhere. A few days after operation, however, the stitches had torn loose and since that time no treatment had been instituted. Patient was delivered by cesarean section. No treatment of fistula done at this time. The patient has not been seen since her discharge from the hospital.

This demonstrates that sphincteric action is possible even when the rectum is not situated in the normal position (Fig. 5).

RECTOVAGINAL (FOSSA NAVICULARIS) FISTULA

R-5583, J. R., female, aged 9 years; full-term, normal delivery. Malformation was first noted when child was 5 months of age, but she was not ill up to the time of admission to the Riley Hospital on February 24, 1930. Diagnosis: imperforate anus, rectovaginal fistula, hydrocephalus. After consultations and examination it was decided to readmit the child in 1 year for operation if her condition warranted it, and the hydrocephalus had not increased. She was readmitted on March 20, 1933, having had no disease, except pertussis, since the last admission. She was again furloughed without operation, but was readmitted on April 13, 1937, at age of 7 years. She was operated upon April 29, 1937. Incision was made in the region of the anal dimple. The hind gut was found to extend into the fossa navicularis. A transverse incision was made freeing this portion of the vagina together with the hind gut. This structure was then anchored to the skin in the normal position of the anus. The perineum was then reconstructed. The child was found to have a double vagina, also. Following surgery the enormous fecal impaction was released by using peroxide irrigations. Associated anomalies: cross eyes, double vagina (Fig. 6).

RECTOVAGINAL (FOURCHETTE) FISTULA

R-2736, N. S., female, aged 9 years. Soon after birth it was noted that the child had a small opening just posterior to the fourchette (frenulum labiorum pudendi). A small amount of fecal matter was seen to exude at this point which was anterior to the rectal sphincter. The patient was operated upon (elsewhere) and simple dilatation of the fistula was done. On August 31, 1936, the patient was operated upon at the Riley Hospital by the perineal route, and the hind gut was brought down to the skin margin. On September 15, 1936, the fistula was excised but later recurred. Following this the patient had repeated rectal dilatations. When she was last heard from the rectofourchette fistula was still present, but the newly formed anus was functioning with good sphincteric control (Fig. 8).

RECTO-URETHRAL FISTULA

R-5423, P. S., male, aged 12 hours; full-term baby. Child was brought to the Riley Hospital because of an imperforate anus, and was operated upon March 2, 1933. Through a perineal incision the blind hind gut was brought down to the skin and anchored with interrupted silk sutures. The child passed meconium, but expired on March 4, 1933. Postmortem was obtained with the findings of imperforate anus, recto-urethral fistula, congenital atresia of the right iliac artery.

R-18960, S. S., female (?), aged 1 day; full-term baby, normal delivery; weight 7 pounds. Physician noted at birth the absence of an anus and malformed genitals. Numerous roentgenograms, including sodium iodide injection, revealed absence of anus, blind hind gut with a recto-urethral fistula. The child was operated upon March 12, 1937, by perineal section. The blind hind gut was identified, found 1¼ inch from the skin margin. It was carefully mobilized, brought down to the skin, opened, and the free edges were sewed to the skin with interrupted plain catgut No. 00 sutures. The hind gut was then flushed with normal saline solution and a large amount of meconium was recovered. The child made an uneventful recovery, and after several manual dilatations he was dismissed from the hospital in good condition on April 28, 1937. Before the baby left the hospital several urinalyses were made and the genito-urinary department was

asked to see the child. The abnormal ureters and bladder indicated clearly the congenital malformation of the urinary tract with infection. However, no treatment was instituted at this time. On May 3, 1937, a letter was received from the physician stating that the baby had died from possible urinary infection. Associated anomalies were in the genito-urinary tract (Fig. 3).

R-19119, G. R., male, aged 9 weeks; full-term child, normal delivery, entered the Riley Hospital on March 29, 1937. The complaint was inability to have normal stools and the presence of a skin tab about the rectum. Diagnosis was incomplete rupture of the rectal membrane with a stenosis, together with a congenital failure of the proctodeum to invert. At operation the hind gut was found to be constricted and to have several small openings which formed draining sinuses about the constricted anus. The operative procedure was as follows: The area around the small sinuses was excised dissecting inward approximately 5 centimeters where the hind gut was entered, and a large amount of hard fecal material was expelled by the patient. The colon was then irrigated thoroughly and the hind gut was sutured to the skin giving a good external opening. Associated anomalies: none. (Fig. 9.)

CONCLUSIONS

1. A study of 23[1] cases of congenital anomalies of the rectum and anus has been made and a brief summary of each case is recorded. This type of anomaly is rare.

2. In over 56 per cent of these cases there were one or more associated anomalies. This proves the wisdom of an old aphorism "If you find one congenital anomaly search for others."

3. The simplest classification is the combined clinical one as suggested.

4. It is necessary to make a careful study of the type anomaly so that correct treatment may be applied. The aid of the fluoroscope in the newborn is described.

5. A study of the various methods of treatment and their results leads one to conclude that early perineal operation is the method of choice.

6. Sphincteric action may be obtained even if the hind gut is not implanted within the anal sphincter or if this sphincter is absent.

[1] Since submitting this paper for publication we have treated 3 more cases. One with narrowing of anus and rectum for a distance of 1 inch (Group I): A girl aged 10 years who complained of partial fecal incontinence. She had an enormously distended sigmoid full of fecal matter. Repeated dilatations resulted in cure. One female child with rectofossa navicularis fistula—3 months of age; operation with complete recovery (Fig. 11). One female infant aged 6 weeks with rectofourchette fistula (Group V) having perineal operation with complete recovery. The latter 2 cases were associated with congenital absence of the anus.

BIBLIOGRAPHY

1. Ball, Charles. The Rectum and Anus, 1887.
2. Cole, Warren H. Congenital malformations of the intestinal tract and bile ducts in infancy and childhood. Arch. Surg., 1931, 23.
3. David, V. C. Embryology and malformations of the rectum. Nelson's Surgery, 5: 161–164.
4. Fraser, John. Surgery of Childhood. Vol. 2. New York: William Wood & Co., 1926.
5. Ladd, William E., and Gross, Robert E. Am. J. Surg., 1934, 23: 167.
6. Murphy, Douglas P. The duplication of congenital malformations present in brothers and sisters and among other relatives. Surg., Gynec. & Obst., 1936, 63: 443.
7. Murphy, Douglas P. Intervals between pregnancies of mothers giving birth to congenitally malformed children. Surg. Gynec. & Obst., 1936, 63: 593.
8. Prentiss, Charles William. Embryology, 1915.
9. Wangensteen, O. H., and Rice, C. O. Imperforate anus—a method of determining the surgical approach. Am. J. Surg., 1930, 92: 77–81.

THE USE OF OS PURUM IN BONE IMPLANTATIONS

With Special Reference to Its Use in Tuberculous Bone and Joint Lesions

SVANTE ORELL, Stockholm, Sweden

IN MY thesis published in 1934,[1] I reported the results of some investigations I had made on the treatment of tuberculous spondylitis, in which small pieces of bone were implanted in the wound over the tibia during the performance of operations to obtain fresh bone for spinal fusions according to Albee's technique. The implanted pieces of bone were removed for gross and microscopic examination after varying periods of time. Repeated x-ray pictures were also taken of the pieces of bone while they still lay in the tissues.

By these investigations, I was able to show that if a fresh autoplastic bone transplant were laid subcutaneously, and another were boiled and laid subperiosteally upon the tibia, newly formed bone tissue would be found in the same degree in both at the end of 14 days. This demonstrated that skeletal connective tissue (represented by periosteum, endosteum, and connective tissue in the haversian canals) in or about the transplant is of fundamental importance for new bone formation. When natural nourishment is restored to the bone tissue in the fresh pieces of bone, it is able to revive and build new bone tissue just as rapidly as the skeletal connective tissue of the tibia is capable of forming bone.

The subperiosteally implanted, fresh, autoplastic pieces of bone behave, therefore, in much the same manner as boiled pieces of bone. Boiled and dried pieces of bone, which have been prepared for some time prior to implantation, are replaced by new bone considerably more slowly, and they are probably sometimes not resorbed at all but produce so-called *tote Einheilung*.

In implantation of bone in the skeleton, one should therefore use bone in such form and in such manner that the skeletal connective tissue in it can quickly revive, and that the living skeletal connective tissue in the compact bone in the bed of the implant may grow into the canal system of the implant as easily and as quickly as possible. To fulfill the first qualification, fresh autoplastic bone is most ideal: to fulfill the second, bone which I have called "os purum," and which is prepared in a special manner, is nearest ideal.

In the canal system of boiled and dried bone which has been stored for a time, resorption and new bone formation occur considerably more slowly after implantation than in the case of fresh bone or freshly boiled bone, probably because the coagulated and dried up connective tissue, and the collagen converted to glue, must first be resorbed before the connective tissue cells can grow into the canals and react upon the hard calcified material. Such dried bone therefore should not be used for clinical transplantation of bone. In order to obtain material satisfactory from all standpoints, "os purum" has been developed. By means of a physicochemical method of preparation, ordinary bone has been freed as completely as possible of connective tissue, fat, and protein foreign to the host, and the calcified substance made as clean as possible without injuring its mechanical strength. The complicated and time-consuming method of preparation consists chiefly of the removal of the blood proteins by soaking in salt solution, the connective tissue by soaking in warm potassium hydroxide, and the fat by soaking in acetone.

Fresh autoplastic bone material has long been used as a routine method in surgical transplantation of bone (see especially Olliers, Axhausen, Lexer, and Albee). This method has its limits, however, since such bone transplants are taken from the skeleton of the patient's own body. The bone transplants are therefore limited in size and shape and are

From St. Göran's Hospital, Stockholm, Sweden.

[1] Orell, Svante. Studien ueber Knochenimplantation und Knochenneubildung. Implantation von "Os purum" sowie Transplantation von "Os novum." Acta Chir. Scand., 1934, 74; Supp. 31.

only slightly variable; and since it is desired also that a portion of the cells survive and take part in the new bone formation, the transplant cannot be handled freely during preparation, but must be treated with the greatest respect.

Barth's theories on this subject dominated the field from 1893 to the time of Axhausen's work in 1908. His theories, based on the microscopic examination of transplants, maintained that the bony substance dies in its entirety and that sterile preserved bone might as well, therefore, be used in bone transplantations. Barth himself used *geglühter Knochen*, bone which was freed of organic substance by burning. These experiments produced no great progress, probably because in burning the bone, animal charcoal and salts remain in the canals to prevent, or at least to hinder, the ingrowth of living cells from the bed of the transplant. Moreover, the glue resulting from the high degree of heating becomes insoluble.

Bone fixed in either alcohol or formalin was often used. After fixation, it becomes very difficult if not impossible for the cells and the tissue juices in the bed of the implant to resorb the tissues in the implant. Tissues hardened in alcohol or formalin can, as a matter of fact, scarcely be digested even by stomach juices. By boiling and drying the bone, the connective tissue and protein material in the canals are coagulated, as mentioned, and the cells in the bed must first react upon these substances and resorb them before they can reach the bone calcium. This resorption of connective tissue in the canals was first suggested by Marchand in 1900, but had not led to the introduction of any practical measures.

Axhausen (1908), however, was responsible for an entirely different conception. He emphasized the superiority of fresh autoplastic bone transplants, and again as Ollier had previously done, demonstrated the importance of the periosteum in the process of new bone formation after transplantation. Sterilized bone, it is true, has since been used as nails, pegs, screws, bridges, planks, etc., in osteosynthesis, but in transplantations in which the main success of the transplants depended chiefly upon the union of the transplant with the skeleton, fresh bone material has chiefly been used. As a result of more recent investigations, however, it is perhaps now permissible to carry out certain surgical implantations with the aid of os purum, especially since such material offers considerable technical advantages.

I have used the implantation of os purum to replace bone which for some reason or other has been resected, most often for tuberculosis. It has been used to fill up the bone defects which result from operation to lessen the chance of producing deformities, and to fix the parts of the skeleton in proper relation to one another in various ways, often after replacing, reshaping, or changing the position of them. Many of the patients with implants of os purum have now been followed for 4 or 5 years. The wounds have, as a rule, healed without complications, and the implants have shown sufficient strength for their mechanical task until they have gradually been rebuilt and replaced by new bone.

In reporting the following series of cases in which os purum has been used, a review will first be made of 3 cases of tuberculous osteitis which were previously described in my thesis. They are included here in order to give the end-results at recent follow-up examinations. In Case 1 were noted good healing and rebuilding after a resection in which os purum was implanted in the diaphysis.

In Case 2 is demonstrated the fact that the implanted os purum, just as fresh autoplastic bone, is rebuilt to perfectly satisfactory form in spite of the fact that the periosteum of the bed has been damaged through suppuration and excision. In my thesis I have shown, in fact, that after septic osteomyelitis in the metacarpal bones with sequestration and extrusion of the sequestrum, no lasting new bone formation is brought about by implantation of os purum after excision of the scar. Os purum melts away and is resorbed without leaving any newly formed bone behind.

In Case 3 an osteoplasty of a phalanx of a finger was done and the os purum was laid against the freshened defect on the surface of the bone.

Case 1. V.N., aged 11 years, history No. 6783, 6949, and 7072. Diagnosis: tuberculous osteitis of the left first metatarsal. On June 29, 1931, a curet-

Fig. 1. Case 1. Patient had tuberculous osteitis of the first metatarsal at age of 11 years. X-ray photographs were taken when patient was 16 years old, 4 years and 8 months after resection and implantation of os purum. The small insert shows the condition 48 days after operation. The double arrow indicates the site of implantation.

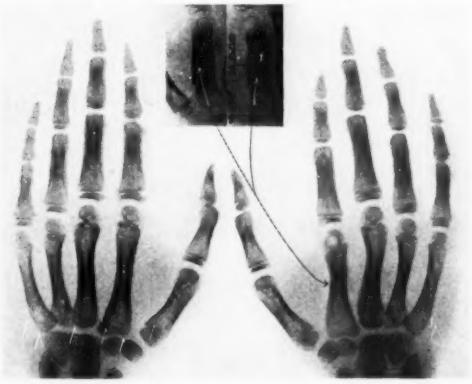
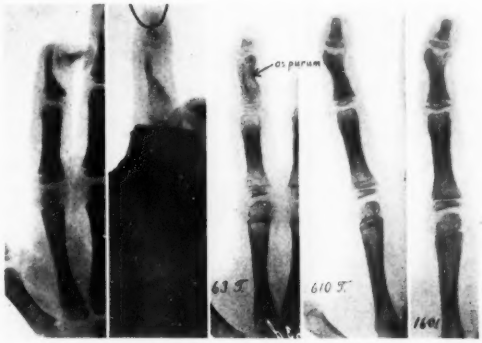


Fig. 2. Case 2. Patient had tuberculous osteitis in the second right metacarpal at age of 7 years. The x-ray pictures, showing the condition after resection followed by implantation of both os purum and fresh autoplastic bone from the tibia, were taken when patient was 12 years old. Inserts show the bone 69 days after operation.

tage of the diseased area was done and a homoplastic bone implantation performed after resection of the bone. The resected bone was replaced by os purum of similar shape. There was primary healing, but about 4 weeks after operation slight swelling and a fistula appeared in the scar, from which clear fluid escaped. The fistula dried up after a few days and healed rapidly. The plaster cast was removed at the end of 11 weeks. Five months after operation the patient was wearing shoes and walking about. He was discharged 6 months after operation with a good functional and anatomical result, and went skiing without difficulty a month after coming home. He was well at follow-up examinations in 1932, 1933, and 1936 (Fig. 1).

Case 2. H.A.V., aged 7 years, history No. 6841. Diagnosis: tuberculous osteitis of the right second metacarpal with sequestration of the metacarpal bone and abscess formation in the soft tissues. On December 22, 1931, the bone was resected and a homoplastic bone implantation (os purum) was done. The metacarpal was cut through proximally and distally and the interlying bone was removed. The abscess in the soft parts was curetted out carefully and cauterized with phenol and alcohol. As a substitute for the resected bone, a homoplastic graft of os purum was used. After operation, the wound suppurated and broke down and on February 25, 1932, the implant was extracted and the wound cavity revised. After the revision, the wound cleaned up quickly and epithelized over. On March 16, 1932, implantations of fresh autoplastic bone and homoplastic os purum were made. The os purum (a proximal phalanx) was fitted into the volar half of the metacarpal region. The dorsal half was replaced by a transplant taken from the tibia of the patient. Healing by first intention occurred. The plaster cast was removed 8 weeks after operation, and the patient was discharged on February 1, 1933. The index finger on the right hand was about 5 millimeters shorter than that on the left. The metacarpophalangeal joint showed a range of 45 degrees of flexion and normal extension. Follow-up examination in March, 1936, showed a good result with complete replacement of the implant by new bone (Fig. 2).

Case 3. M.H., aged 7 years, history No. 6828. Diagnosis: tuberculous osteitis of the left second metacarpal with deformity. On August 11, 1931, homoplastic os purum (a middle phalanx) was im-



a b c d e

Fig. 3. Case 3. Deformity of the middle phalanx of the index finger after healing of tuberculous dactylitis in boy of 7 years. a and b, show finger during extension; c, 63 days, d, 610 days, and e, 1601 days after the implantation of os purum into the bone defect, producing almost complete restoration of the shape of the finger, patient now 12 years of age.

Fig. 4. Case 6. Bone cyst in the right tibia for which curettage and implantation of os purum spongiosum was done. Figure shows lateral x-rays of the knee: left, before operation; center, 169 days after operation; and right, 711 days after operation. Patient, 27 years old.

planted into the defect in the bone. The wound healed by first intention. The extension wire and plaster cast was removed at the end of 2 months and active motion of the interphalangeal joints begun. The result was good both from a functional standpoint and by x-ray, with almost complete restoration of the distal interphalangeal joint and of the shape of the index finger. Follow-up examination in March, 1936, showed a good result, with a complete rebuilding of the implant by new bone (Fig. 3).

The rebuilding of os purum may thus be seen to be dependent entirely upon the connective tissue which is present in the bed. If the os purum is implanted beneath the periosteum or next to living bone which contains connective tissue, it is rebuilt without difficulty. If only extraskeletal connective tissue is found in the area around the os purum, the latter is absorbed without being replaced by new bone.

In Case 4 the patient, a 47 year old woman, had a tuberculous lesion which was curetted out of the calcaneous and filled with os purum spongiosum. The rebuilding of the implant progressed slowly and was not complete by x-ray 720 days after operation, but judging by its clinical appearance, it should have been complete.

Case 4. I.R., aged 47 years, history No. 6709. Diagnosis: tuberculous osteitis of the left calcaneus with sequestrum. On August 11, 1931, the lesion was curetted out under local anesthesia and os purum spongiosum was implanted. Healing by first intention occurred. On October 21, a superficial necrosis was noted in the scar of the operation on the lateral side of the heel, from which clear fluid exuded. Later in November – December, 1931, the wound healed completely. The patient died May 6, 1935, of uremia. She was examined the day before death, and the heel was then well healed and looked entirely normal.

The 3 following cases illustrate the filling-out of defects in the cancellous bone contiguous to the knee joint with os purum spongiosum. Cases 5 and 6 were also reported in my thesis, and are described again here after recent follow-up examinations. Case 7 is rather interesting in that the patient had a large abscess extending from the bone lesion into the muscles which was found at the time the implantation was done. The implant began to be rebuilt as soon as the fistula closed and the abscess began to be resorbed.

Case 5. K.V.J., aged 16 years, history No. 7050. Diagnosis: osteitis fibrosa of the medial condyle of the right tibia. At admission the patient showed general muscular atrophy of the right leg. On the posterior surface of the lateral condyle of the tibia there was considerable tenderness and a somewhat doughy swelling. The motion in the knee joint was fairly good. On May 26, 1933, curettage of the lesion was done and os purum spongiosum was implanted. The report of the pathological examination was made by Dr. C. O. Forselius as follows: "The microscopic picture may be said to lie between that of a fibrosarcoma and a giant cell tumor, in any event non-malignant." On August 29, 1933 he was discharged healed with good motion in the knee joint but with a slight limp on walking. On August 28, 1935, he had no complaints and had good motion.

Fig. 5. Case 7. Roentgenogram 10 months after curettage of tuberculous lesion and implantation of os purum, in patient 29 years old. The os purum has begun to be replaced by new bone.

CASE 6. H.H.R., aged 27 years, history No. 7105, was admitted to hospital July 15, 1933, with a bone cyst in the medial condyle of the tibia. He had been previously treated in the United States of America. At admission the right knee was fixed in about 45 degrees of flexion and there was marked muscular atrophy of the leg. There was only slight swelling but pronounced tenderness over the medial condyle of the tibia. At operation on July 27, 1933, the tuberculous lesion was curetted out and os purum spongiosum was implanted. The lesion, of lima bean size, contained clear fluid, but no necrotic tissue. It was filled with os purum, and the healthy bone which had been removed was replaced in the bone canal also. Healing by first intention occurred. Seven weeks after operation the patient was allowed to get up without a dressing and was permitted active motion. He was discharged on October 21, 1933, with normal extension and 105 degrees of flexion. On November 12, 1934, he was in good general condition. He had no complaints referable to the knee, and had as good motion in the knee which had been operated on as in the other There was no muscular atrophy. A certificate of good health was given for his return to the United States. The microscopic report by Dr. C. O. Forselius read as follows: "Bone tissue, partly necrotic, partly forming new bone. The bone marrow is in large part fatty and poor in cells. Here and there a collection of lymphocytes and plasma cells but nowhere a picture typical of osteitis fibrosa." (Fig. 4.)

CASE 7. V.F., aged 29 years, history No. 7371. This patient had a tuberculous focus of hazel-nut size in the medial femoral condyle of the right femur with a large abscess in the soft parts. On April 30, 1935, the lesion was removed by operation and os purum spongiosum was implanted. Healing by first intention occurred. Repeated abscesses had to be drained subsequent to the operation. A fistula appeared again on August 17 and 5 to 10 cubic centimeters of thick pus was expressed through it. A progress note on November 24, 1935, stated that no suppuration

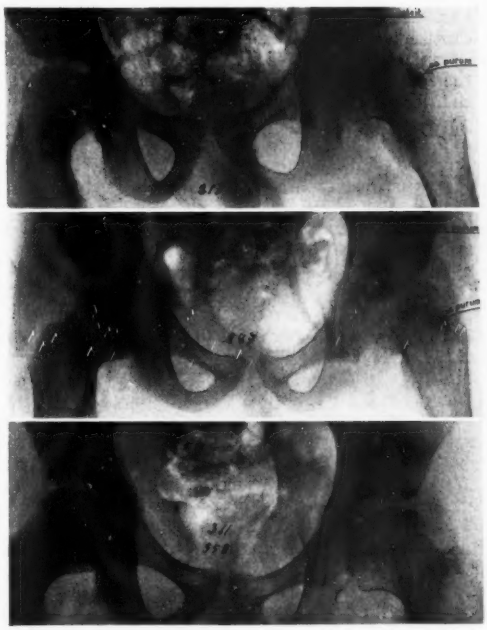


Fig. 6. Case 8. Top, 217 days after curettage of tuberculous lesion in the neck of the femur and implantation of os purum in boy of 7 years; center, 301 days later when a similar operation was performed on the acetabulum; bottom, 558 days after the first operation and 311 days after the second operation.

from the fistula had occurred for 14 days. The knee was then non-tender to palpation and there were no signs of abscess formation. The patient lacked 10 degrees of full extension, and the flexion ability lacked 30 degrees. She was out of bed the entire day without complaints. She was discharged on March 8, 1936, in good general condition. The knee was healed and had improved in its mobility. The muscles of the leg were stronger and there was beginning replacement of the os purum by x-ray (Fig. 5).

Case 8 showed a tuberculous lesion in the neck of the femur which was curetted out and filled with os purum spongiosum. Half a year later a lesion was discovered in the acetabulum and was similarly treated. The wounds healed well after both operations. The joint space was normal and the function of the joint was good. In Case 9, a walnut-sized lesion in the os pubis was curetted out and filled with os purum with a similar result.

CASE 8. L.B.O., aged 7 years, history No. 7369. Diagnosis: tuberculous osteitis of the left femoral

neck and acetabulum. On September 18, 1934, the diseased area was removed surgically and os purum spongiosum implanted. In the anterior portion of the junction between the femoral neck and the trochanter, granulation tissue was encountered, and a pea-sized area of bone necrosis was curetted out and replaced by os purum. Healing by first intention occurred. On May 23, 1935, a diseased focus in the acetabulum was removed by a second operation and os purum spongiosum was implanted. A triangular flap of the outer table of the ilium was raised up with the base toward the edge of the acetabulum. The focus was reached with a curette, cauterized with carbolic-alcohol, and filled with os purum. First intention healing occurred. On May 3, 1936, the patient was in good general condition. The gait and motion in the hip joint was good (Fig. 6).

CASE 9. E.M.K., aged 4 years, history No. 7424. Diagnosis: tuberculous osteitis in the right os pubis with a walnut-sized lesion in the superior ramus of the os pubis. At operation on April 4, 1935, the diseased area was removed and os purum spongiosum was implanted, under ether anesthesia. The anterior wall of the symphyseal cartilage was intact. It was broken through carefully with a chisel, whereupon a cavity was encountered filled with necrotic and partially caseous masses. These were removed. The cavity had a very irregular shape, but was filled up as well as possible with os purum. Healing by first intention occurred. On May 3, 1935, the patient was in good general condition. Rebuilding of the os purum had taken place to a considerable degree according to x-rays but was not yet fully complete.

Cases 10, 11, and 12 exhibited tuberculous lesions with involvement of the neighboring joints in one or more tarsal bones. These lesions were curetted out and filled with os purum. In all these cases, healing was by first intention and the subsequent function was good. Of these cases, Case 10 has been followed 483 days and the rebuilding has been good. Case 12 has been followed 1½ years.

CASE 10. W.G.S., aged 24 years, history No. 7236. Diagnosis: tuberculosis of the right tarsus. Neither tenderness nor swelling over the talocalcaneal joint was very great although the patient complained of pains in the heel upon walking. There was some limitation of dorsal flexion of the foot. The right calf measured 3 centimeters less in circumference than the left. At operation on May 12, 1034, the lesion was found lying immediately against the talocrural joint and was curetted out and replaced with os purum spongiosum under spinal anesthesia. The pathological report was tuberculosis. The wound healed by first intention, and the patient was discharged on July 5, 1934, free of complaints. On September 7, 1935, he still was without complaints and had good motion in the foot.

CASE 11. J.P.J., aged 64 years, history No. 7375. On the medial border of the right foot there was an ulcer about 1 centimeter long at the anterior border of the os naviculare with low grade suppuration. There was no swelling of the soft parts. There was tenderness to palpation on the dorsum of the foot over the os naviculare. At operation on November 17, 1934, under local anesthesia, a small cavity containing granulations was encountered which extended forward toward the joint between the os naviculare and the first os cuneiforme. The lesion together with the neighboring bone and portions of the cartilage were curetted out and replaced with os purum. The wound healed by first intention, and the patient was discharged on February 21, 1935, with a good anatomical and functional result.

CASE 12. A.E.N., aged 25 years, history No. 7191. Diagnosis: tuberculosis of the tarsus with multiple osteitis. For about 2 months there had been tenderness upon palpation of the dorsum of the right foot especially immediately anterior to the head of the talus. By x-ray, osteoporosis of the metatarsal bones was apparent and the joint cartilage of the small joints of the right foot did not show as clearly as those of the left foot. Curettage of the bone lesion was performed on November 30, 1930, under spinal anesthesia. The joint capsule between the os cuboideum and the third os cuneiforme showed pathological changes and was excised. In two neighboring portions of the bone, tissue showing tuberculous changes was curetted away. The portions curetted out were replaced by os purum spongiosum. The wound healed by first intention. At follow-up examination on May 3, 1936, the result was good both functionally and by x-ray.

In Cases 13 to 17, tuberculous lesions of the bone at the wrist, with involvement of the neighboring joints, were curetted out. In 3 of the cases (13, 15, and 17) the healing and rebuilding has been exceptionally good. Two of the cases which had large abscesses and fistulas before operation had postoperative complications; Case 14, a flaring up of pulmonary tuberculosis (patient referred to a sanatorium); Case 16, an old woman, a pulmonary embolus 5 months after operation causing sudden death.

CASE 13. E.E., aged 24 years, history No. 7101. Diagnosis: tuberculous arthritis of the right radiocarpal joint with abscess formation and threatening perforation of the skin. At operation on August 1, 1933, the bone lesions in the os naviculare, os lunatum, and radius were curetted out under brachial plexus block anesthesia, and os purum was implanted. The wound healed by first intention. However, in the third week after operation, a few drops of clear fluid appeared through a small fistula in the scar, but subsequently remained dry. Three months

TABLE I.—IMPLANTATION OF OS PURUM IN RESECTIONS OF THE ANKLE JOINT FOR TUBERCULOSIS

Case No.	History No.	Patient's initials	Age	Sex	Resection		Healing	Walked without cast mos. postoperative	Rebuilding of implant—days after operation	Form of foot	Remarks
					Date	Anesthesia					
18	6633	E. I. K.	17	♂	9- 9-31	E	Primary	3	Good, 330	Good	15–20° motion
19	6573	K. M. A.	9	♀	9-19-31	E	Primary	2½	Good, 328	Good	Ankylosis
20	6838	B. E.	20	♂	4- 6-32	E	Primary	2	Good, 388	Good	5° motion
21	6877	S. C. S.	16	♀	10- 6-32	S	Primary	4	Good, 650	Good	Ankylosis
22	7005	T. I. P.	25	♀	5-11-33	E	Primary	4	Good, 390	Varus	Ankylosis
23	7151	I. L.	13	♀	11-30-33	E	Primary	3	Good, 422	Good	Ankylosis
24	7280	A. E. F.	49	♀	1-17-35	S	Fistula		0	Good	Ankylosis
25	7359	B. G. C.	18	♂	1-26-35	S	Primary	3	Good	Good	Ankylosis

E=Ether anesthesia; S=Spinal anesthesia.

after operation the plaster cast was dispensed with and free use was permitted. The functional and anatomical result was good and there was no collapse of the os purum. A fair amount of motion returned in the wrist joint. Patient has been reexamined every 6 months.

CASE 14. E.I.E.A., aged 30 years, history No. 7047. Diagnosis: tuberculosis of the wrist joint with abscess formation and threatening perforation of the skin. A resection of the wrist joint was performed on August 1, 1933, under ether anesthesia. The resected bone was replaced by a layer of os purum spongiosum. Healing was complicated by the appearance of a fistula which soon dried up. The patient was referred to a sanatorium for pulmonary tuberculosis 6 months after operation, where she died a few months later.

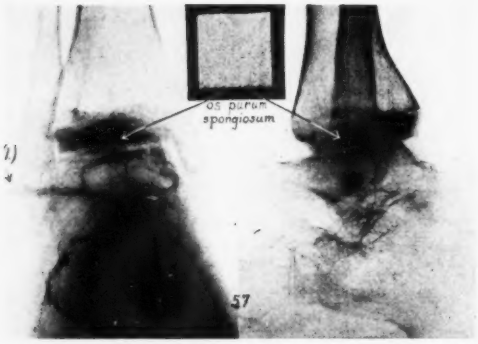
CASE 15. B.A.O., aged 26 years, history No. 7366. Diagnosis: tuberculosis of the left wrist joint with multiple areas of osteitis. There had been increasing diffuse swelling of the left wrist with the formation of a fluctuant abscess on the dorsal aspect. Curettage of the bone lesion and implantation of os purum spongiosum was done on October 10, 1934. The joint capsules were excised and replaced with os purum. Healing appeared to be by first intention, but about 2 months after operation there was some serous discharge through a small fistula in the scar. A small abscess appeared in the skin and was incised. After this procedure was carried out prompt healing followed.

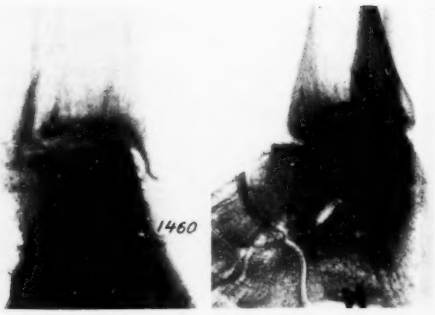
CASE 16. Age 68 years. History No. 7399. Diagnosis: tuberculosis of the wrist with abscess formation and threatening perforation. Perforation occurred on December 29, 1934. At operation on January 3, 1935, a large tuberculous lesion was curetted out of the wrist bones and the radius and was replaced by os purum spongiosum, under brachial plexus block anesthesia. Healing was complicated by suppuration through a fistula. The patient died suddenly of a pulmonary embolus on May 7, 1935. No postoperative x-ray pictures had been taken before death occurred.

CASE 17. A.E.P., aged 29 years, history No. 7421. Diagnosis: tuberculosis of the right wrist. There was marked swelling and destruction of the end of the radius and the proximal carpal bones at admission. Curettage of the lesion was done on June 7, 1935, and the removed bone was replaced by implantation of os purum spongiosum under brachial plexus anesthesia. The wound healed by first intention. The plaster cast was dispensed with after about 2 months. The patient was discharged on September 13, with the wound well healed. The hand was in good position and had good contour, without collapse of the area. There was only a couple degrees of motion in the wrist joint, but there was good motion in the finger joints. At follow-up examination on February 3, 1936, the mobility and strength had increased. The result was good, both from a functional standpoint and by x-ray.

Table I gives data regarding 8 cases (Cases 18 to 25) of tuberculosis of the ankle joint in which resection was performed and the resected bone was replaced by a piece of os purum spongiosum with the aim to preserve the shape of the foot as much as possible. In all except Case 24, in which a fistula was present before operation, healing was by first intention. The strength and rebuilding of the implants, and also the shape of the foot, have all been good.

CASE 18. E.I.K., aged 17 years, history No. 6633, 6956, 7073, 7363, and 7586. The patient had an old tuberculosis of the right talocrural joint which had flared up several times. A trial of conservative treatment was first made, but swelling, tenderness on pressure, and pains about the joint persisted. On September 9, 1931, a resection of the ankle joint was done and the resected bone was replaced by implantation of homoplastic os purum spongiosum. The wound healed by first intention, and the pa-





Figs. 7 and 8. Case 18. Figure 7 was taken 57 days after resection of the ankle joint and insertion of os purum for tuberculosis in a patient 17 years of age. Figure 8 was taken 4 years after operation.

tient was out of bed walking in a cast 3 months after operation. There was functional and anatomical healing without collapse of the os purum (Figs. 7 and 8). Follow-up examination in August, 1935, showed the foot to be in good position with 5 to 10 degrees of equinus. The range of motion for plantar and dorsal flexion was 15 to 20 degrees. A few degrees of pronation and supination were present. There was no pain on motion and general strength was satisfactory. The calf musculature of the right leg was somewhat atrophied. He could walk remarkably well and could run easily and without difficulty. The patient worked in a lumber yard carrying planks and lumber without trouble.

Case 19. K.M.A., aged 9 years, history No. 6573, 6955. The patient was admitted to the hospital with signs of an acute process in an area of old tuberculosis in the right talocrural joint. The patient was treated conservatively at first, but because of angulation of the foot, resection of the joint was decided upon. This was performed on September 9, 1931, and the resected bone was replaced with a piece of os purum spongiosum. The wound healed by first intention, and the patient was up and walking with a plaster cast 2½ months after operation. The functional and anatomical result was good, without collapse of the os purum. The patient was discharged on April 22, 1932. Follow-up examination on August 10, 1932 showed the foot to be well healed and ankylosed in good position.

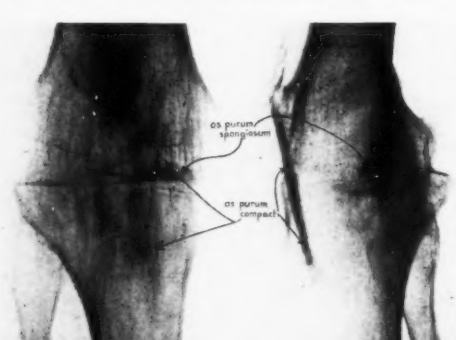


Fig. 9. Case 26. Tuberculosis of the knee joint in patient aged 37 years. Anteroposterior and lateral roentgenograms 4½ years after resection of the joint and implantation of os purum spongiosum together with a tongue of os purum compactum.

Case 20. B.E., aged 20 years, history No. 6838. Since the end of 1929 the patient had had symptoms from tuberculosis of the talocrural joint, sometimes improving, then becoming worse again. There had been abscess formation of late. On April 6, 1932, resection of the joint was performed and the resected bone was replaced with a layer of os purum spongiosum. On June 9 the patient was out of bed walking with a plaster cast and was discharged on September 30 with a leather support which he wore until January 15, 1933. He then walked well without it. Three years after operation, on July 14, 1935, his general condition was good. The sedimentation rate was 4 millimeters in an hour. The position of the foot was good and there was no difficulty in walking even when the gait was rapid. There was about 5 degrees of motion in the ankle joint. There was no impairment of motion in the toes or knee and he had no pain or tenderness. He has now learned the tailoring trade, having been a textile worker prior to his illness.

Case 21. S.C.S., aged 16 years. History No. 6877. The patient entered with an exacerbation of old tuberculosis of the left talocrural joint. Since her fistulas had closed on September 1, 1932, a resection of the joint was done October 6, 1932, and the resected bone was replaced with os purum spongiosum. First intention healing was obtained. The patient walked without her plaster cast in the fourth month after operation. There was good functional and anatomical healing without collapse of the os purum. She was discharged on March 19, 1933, with

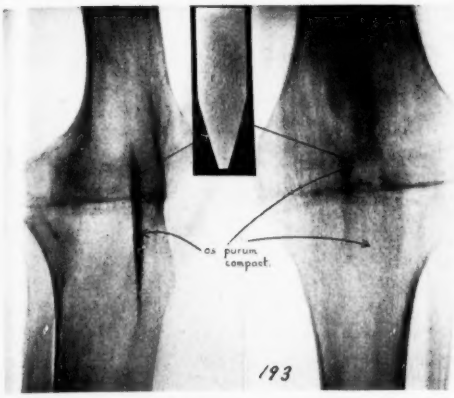


Fig. 10. Case 39. Tuberculosis of knee joint in a patient 21 years old. Anteroposterior and lateral views 193 days after resection of the joint and implantation of a tongue of os purum compactum.

Fig. 11. Case 37. Tuberculosis of the knee joint with atrophic and friable cancellous bone in patient 27 years old. Roentgenogram shows condition 111 days after resection of the joint and implantation of a thick plate of os purum spongiosum.

the wound well healed and with good motion in the joints of the foot. The cast was dispensed with on March 10, 1935. Follow-up examination 2½ years after operation showed good general condition. The patient walked well without a limp, but she experienced occasional ache in the joints of the foot with change in weather. She works at home.

Case 22. T.I.P., aged 25 years, history No. 7005. Diagnosis: tuberculosis of the left talocrural joint. The patient had had trouble with the left foot since the beginning of 1932. An operation was decided upon, since the trouble did not disappear in spite of bed care and fixation in plaster. A resection of the joint was done on May 11, 1933, and the resected bone was replaced with os purum spongiosum. Healing was by first intention. The plaster cast was removed 2 months after operation, and 4 months after operation the patient was able to walk without a supporting bandage. There was good functional and anatomical healing without collapse of the os purum, but there was some valgus position of the foot because the os purum had not been correctly shaped. At follow-up examination on June 12, 1934, the general condition was good. The valgus position was still present. There was 10 degrees of motion in the ankle joint. She had worked at home housekeeping for the last 7 months without trouble.

Case 23. I.L., aged 13 years, history No. 7151. The patient was admitted to the hospital August 28, 1933, with a diagnosis of tuberculosis of the left talocrural joint. For 4 weeks a latent tuberculosis of this joint had been flaring up. Operation was decided upon because of threatening perforation of secondary abscesses. A resection of the joint was performed on November 30, 1933, and os purum was inserted to replace the resected bone. Healing was by first intention and the patient was out of bed walking without a cast on March 1, 1934. He was discharged on May 14, 1934, with some atrophy of the musculature of the left thigh and calf. He had then been up and about for a month and could walk well. The foot had good shape and good function. On August 17, 1935, the general condition was good, and the gait was satisfactory. The foot looked well, still had good shape, and did not swell. The sedimentation rate was 25 millimeters. The patient was taking part in all kinds of sport.

Case 24. A.E.F., aged 49 years, history No. 7280. Diagnosis: tuberculosis of the right talocrural joint with fistula formation. The patient had had aches

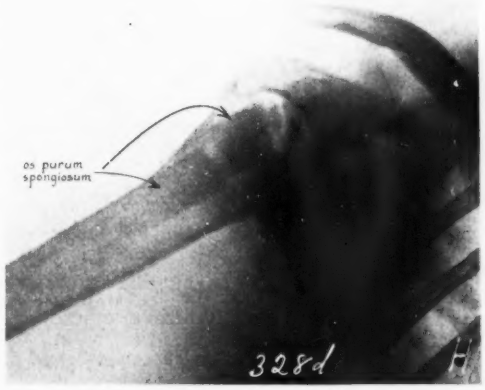


Fig. 12. Case 47. Tuberculosis of the shoulder joint in a woman 52 years of age. Roentgenogram shows the condition 328 days after shoulder joint resection with implantation of os purum in a large defect in the cancellous portion of the head of the humerus.

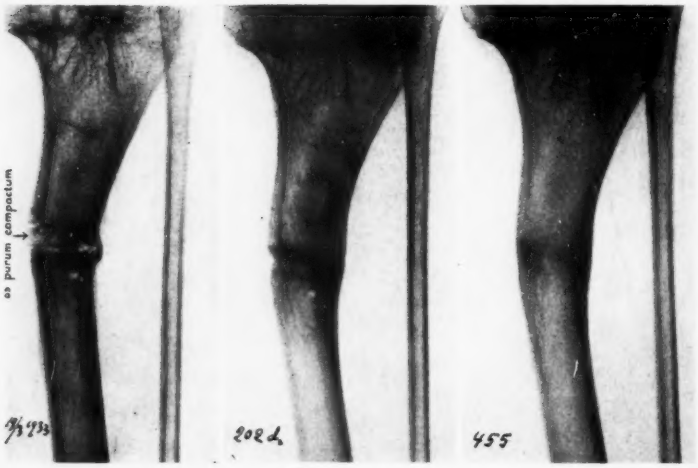


Fig. 13.

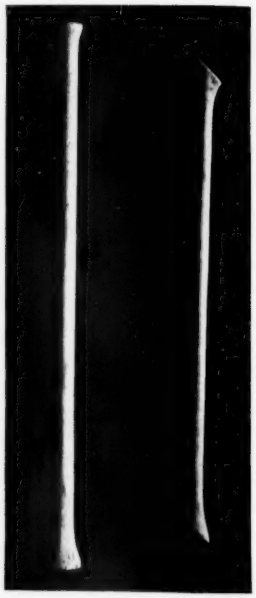


Fig. 14.

Fig. 13. Case 49. Genu varum following tuberculous coxitis in a girl of 13 years. Roentgenograms show condition, left, the day following an infracondylar osteotomy on the tibia and interposition of os purum compactum to maintain good position; center, 202 days after operation; and right, 455 days after operation.

Fig. 14. Tampons of pear-wood with which the os purum spongiosum is packed into the site of implantation.

and swelling in the right foot since the beginning of 1934. At admission on May 15, 1934, there was on the right foot just lateral to the malleolus a fistula about 1 centimeter in diameter and with considerable discharge. The fistula had soft granulations in its depths and the skin immediately surrounding it was bluish red in color. The underlying tissues were somewhat swollen. Motion of the ankle joint was especially painful upon flexion. On January 15, 1935, there was only a slight amount of secretion from the two fistulas. A resection of the ankle joint was performed on January 17, 1935. Many masses of tuberculous granulations were found in the capsule and on the surface of the joint. The joint cartilage was missing. The granulations were removed and the surface of the joints was scraped clean and smoothed off, after which a layer of os purum spongiosum about 1 centimeter thick was placed between the surfaces of the resected area. On July 13 the patient was permitted to walk with a plaster cast, and on December 27 it was dispensed with. At follow-up examination on January 29, 1936, it was learned that there had at times been some serous discharge through a small fistula since operation. X-ray examination revealed that the implant had maintained itself well, but had not yet begun to be rebuilt.

CASE 25. B.G.E.C., aged 17 years, history No. 7359, 7394. Diagnosis: tuberculosis of the left talocrural joint. The patient was admitted to the hospital on August 17, 1934. There had been swelling of the foot since March, 1934. A resection of the joint was done on January 26, 1935. The resected bone was replaced with a layer of os purum spongiosum, and healing by first intention was obtained. The plaster cast was removed April 8. The patient walked without support on April 24 and was discharged June 6, 1935 without complaints and with a well healed wound.

In Table II, 18 cases (Cases No. 26 to 43) of knee joint tuberculosis treated by resection are outlined. I have not included the full case histories for lack of space. The implantation of os purum in these cases is only one step in a resection which is often quite complicated and meticulous in its performance.

At resection, the defects in the resected surfaces were replaced with os purum spongiosum, and the resected ends were united by osteosynthesis by driving in a strong tongue of os purum compactum through the anterior portions of the tibia and femur in the frontal plane. The latter procedure is an advantageous technical detail in the operation. After the tongue of bone has been driven in, it is considerably easier to put on the plaster cast with the leg in good position than if only sutures are used. More important, however, is the fact that bony union becomes firm earlier

TABLE II.—IMPLANTATION OF OS PURUM IN RESECTIONS OF THE KNEE JOINT FOR TUBERCULOSIS

Case No.	History No.	Patient's initials	Age	Sex	Osteosynthesis		Healing	Cast removed—mos. after operation	Rebuilding of implant and result
					Date	Anesthesia			
26	6840	A. B. A.	37	♂	12-22-31	E	Primary	6	Good
27	6879	A. L. O.	28	♀	5-21-32	E	Primary	4	Good
28	7044	F. A.	22	♀	5- 9-33	E	Fistulas	11	Good
29	6993	J. A. P.	23	♂	6- 8-33	S	Primary	Followed at another clinic	
30	7116	J. G. W.	16	♂	8-24-33	S	Primary	Not recorded	
31	7053	A. M. J.	50	♀	10-26-33	S	Primary	7	Good
32	7293	E. V. E.	24	♀	6-26-34	S	Primary	7	Good
33	7182	F. S.	31	♂	7-17-34	E	Primary	7	Good
34	7346	E. B.	20	♀	7-24-34	S	Primary	6	Good
35	7317	O. F. K.	45	♂	8- 7-34	E	Died 8-8*		
36	6985	S. W.	16	♂	10- 9-34	E	Primary	Not recorded	
37	7231	B. J.	27	♀	10-16-34	S	Primary	Referred to sanatorium for pulmonary tuberculosis	Good†
38	7296	T. G. Y.	23	♂	1-18-35	S	Primary	Referred to sanatorium for pulmonary tuberculosis	Good†
39	7416	H. M. L.	21	♀	9-27-35	S	Primary	6½	Good
40	7605	S. O. K.	24	♂	10-12-35	S	Primary		Good
41	7366	B. A. O.	27	♂	10-18-35	S E	Primary		Good
42	7630	K. I. D.	25	♀	1-18-36	S	Primary		Good
43	7652	K. A. H.	18	♂	1-30-36	S	Primary		Good

E=Ether; S=Spinal anesthesia.
*Heart failure.
†Refers to result only.

with such an osteosynthesis, and the plaster cast may be taken off as early as 6 months after operation. The expense of a leather support is eliminated by these measures.

Judging from the x-ray pictures, it takes about 1 year before the bony structures in the tibia and femur begin to grow over into one another. In the anteroposterior views, the tongue of bone is well outlined until about 400 days after operation; subsequently it is difficult to make out. In the lateral views, however, the tongue of bone may be seen to be more dense than the surrounding bone as late as 4 years after operation. Compact os purum is rebuilt very slowly (see Figs. 9, 10, and 11).

In Table III, 5 cases of shoulder joint tuberculosis which have been treated by resection are described (Cases 44 to 58). At operation, the defects in the resected ends have been replaced with os purum spongiosum and the end of the humerus held in position by means of a tongue of bone driven into the anterior margin of the glenoid labrum. Healing has invariably been by first intention and union has been good. The rebuilding of the implant has also been good. In these cases evipan and ether anesthesia have been used in combination, with great advantage. Since the cases have not been followed more than 1 year, the rebuilding of the implants is not yet complete.

CASE 44. E.G.K., female, aged 18 years, history No. 7289. Diagnosis: tuberculosis of the right shoulder joint. The patient had had pain, tenderness, and increasing stiffness in the right shoulder joint, since 1931. On March 29, 1933, a resection of the shoulder joint was done under ether anesthesia. The head contained extensive necrotic areas which were cleaned out. The posterior portion of the capsule of the shoulder joint contained a great deal of granulation tissue and caseous material. A secondary abscess had formed in the axilla. All the diseased tissue was removed. The cartilage of the glenoid cavity was necrotic with caseous areas beneath. These were curetted out also. When the head of the humerus and the glenoid cavity were smoothed off, they did

not fit each other well; the head tended to luxate anteriorly. A tongue of os purum was therefore driven into the anterior portion of the glenoid rim in order to hold the head in place. Good position then seemed to be maintained. On April 29, 1936, the general condition was good. The patient stated that she occasionally had pain in the region of the scapula, probably originating in the musculature. The shoulder joint was ankylosed with the upper arm held at an angle of 60 to 70 degrees with the lateral edge of the scapula.

CASE 45. O.K., male, 31 years of age, history No. 7395. Diagnosis: tuberculosis of the left shoulder joint. The patient had been well until the autumn of 1933, when he first noticed a swelling in the left supraclavicular fossa. This swelling produced no subjective discomfort, but increased gradually in size. In May, 1934, it was of hen's egg size. On February 12, 1935, the shoulder joint was resected under ether anesthesia. The head of the humerus contained a sequestrum the size of a walnut, which was removed. The joint capsule was also removed. The glenoid cavity was cleaned out with a curette, and a tongue of os purum was driven into the anterior edge, against which the smoothed off head of the humerus rested so that it was held in good position. A fenestrated circular plaster bandage was placed about the thorax, upper arm, and forearm. The wound healed by first intention and the patient was discharged May 25, 1935, wearing the plaster cast. He has returned for observation every 3 months. On April 6, 1936, the general condition was good and the plaster was removed. There was ankylosis of the shoulder joint. Remnants of the tongue of bone were still visible in the x-ray pictures.

CASE 46. T.A., male, aged 29 years, history No. 7435. Diagnosis: tuberculosis of the right shoulder joint. Since July, 1934, the patient had had continual trouble with increasing stiffness in the right shoulder joint. On April 5, 1935, the shoulder joint was resected under evipan-ether anesthesia. The cartilage on the humeral head was necrotic and was loosened over its greater part. Several pea-sized tuberculous areas in the head were curetted out and cleared of granulations. The entire capsule was carefully removed. The glenoid cavity was curetted free of necrotic cartilage, granulations, and caseous material. In the lower portion of the glenoid cavity, a funnel-shaped cavity was encountered having a base about 1 centimeter in diameter. This was also curetted out. The entire field of operation was cauterized with carbolic acid and alcohol, and the defect in the glenoid cavity was filled with os purum spongiosum. The head was easily fitted into the glenoid cavity and fixed in 90 degrees of abduction, 20 degrees of forward flexion, and 20 degrees of internal rotation. A fenestrated circular plaster was made to include the thorax, the upper arm, and forearm. Healing was by first intention, and the patient was discharged on June 5, wearing the plaster cast. He returned every 3 months for observation. On February 5, 1936, the shoulder joint looked fine and had good stability. The scar was well healed. There was good motion in the elbow and hand, and the strength was good. X-ray picture showed that healing and consolidation were taking place.

CASE 47. A.P., aged 52 years, history No. 7392. Diagnosis: tuberculosis of the right shoulder joint. The patient had had ache, soreness, and stiffness in the right shoulder joint since 1930, and had recently had a secondary abscess. The joint was resected on March 4, 1935. In the center of the head of the humerus, a large caseous necrosis was found. This was curetted out and filled with os purum spongiosum. Healing occurred by first intention, and the patient was discharged on August 24, 1935, with the arm in a leather support. On January 26, 1936, the joint was well healed with the arm in good position. The joint has since become ankylosed (Fig. 12).

CASE 48. T.B., male, aged 45 years, history No. 7425. Diagnosis: tuberculosis of the right shoulder joint. The patient had had trouble with the right shoulder joint since childhood. During the last 2 years he had had increasing aches and pains in it together with diminution in the mobility of the joint. The patient consented to operation, and on March 13, 1935, a shoulder joint resection was done under evipan-ether anesthesia. The head was found to be luxated and was replaced. The joint capsule was excised and the wound cavity cauterized with carbolic acid and alcohol. Because of the marked adduction contracture, the head was smoothed off, whereupon lesions were found within it. One bean-sized area extended down into the neck of the humerus. These were curetted out and filled with os purum spongiosum. In order to hold the head in the glenoid cavity, a tongue of os purum was driven into the anterosuperior portion of the glenoid rim. A fenestrated circular plaster cast was made to include the thorax, upper arm, and forearm. Healing was by first intention, and the patient was discharged on May 24 with a shoulder cast. On April 10, 1936, the general condition was good. There was bony union by x-ray examination. The patient had removed the cast 14 days previously. He was engaged in sloyd work, and played the piano and violin without difficulty.

Case 49 is one of interposition osteosynthesis of the tibia for genu varum following tuberculous coxitis. In the same manner that a bone fragment can prevent reposition in a comminuted fracture and fix the ends of the bone in a faulty position, so through the use of interposition in an osteotomy, bone or joint resection, fracture, etc. reposition and fixation of the ends of the bone in the desired position may be obtained. This is especially important in osteotomies, etc. in which fixation after reposition often cannot be done at all or with great difficulty solely by means of external appliances.

TABLE III.—IMPLANTATION OF OS PURUM IN SHOULDER JOINT RESECTIONS FOR TUBERCULOSIS

Case No.	History No.	Patient's initials	Sex	Age	Resection			Healing	Remarks	Rebuilding of implant	Ankylosis
					Date	Anesthesia	Type of operation				
44	7289	E. G. K.	♀	19	3-29-33	E	B	Primary	Cast removed 5-28-34	Good	Yes
45	7395	O. K.	♂	33	2- 2-35	E	B	Primary	Leather support—removed 4-6-36	Good	Yes
46	7435	T. A.	♂	30	4- 5-35	Ev-E	D	Primary	Leather support—	Good	Yes
47	7392	A. P.	♀	52	3- 4-35	Ev-E	D	Primary	Leather support—	Good; not complete	Yes
48	7425	T. B.	♂	46	3-13-35	Ev-E	B-D	Primary	Leather support—removed 3-25-36	Good; not complete	Yes

E=Ether; Ev-E=Evipan-Ether; B=Tongue of os purum; D=Defect in bone substance replaced by os purum.

CASE 49. E.B., aged 13 years, history No. 6846. Diagnosis: genu varum following tuberculous coxitis. On March 18, 1933 an infracondylar osteotomy of the tibia was done and os purum was implanted. After the usual incision in the soft parts, the operation was carried out with drill and osteotome. With retractors the ends of the bone were forced apart, and small pieces of os purum were interposed between the medial ends of the bones so that the proper relationship between them existed. The periosteum and the overlying soft parts were sutured. A fenestrated circular plaster cast was placed about the leg and foot. Healing was by first intention. At the end of 8 weeks, the patient was up and walking with the plaster cast on. Figure 13 shows the x-ray pictures the day after operation, 202 days after operation, and 455 days after operation. The patient was discharged on January 17, 1934, with complete ankylosis in the left hip joint and with the lower leg in good position. She limped slightly but otherwise walked quite well.

Implantation of os purum has given healing by first intention as a general rule. During the third or even the seventh week after implantation, a fistula has sometimes appeared in the scar and serous fluid broken out through it, probably due to tissue necrosis. The discharge has usually ceased after 1 or 2 weeks, and the wound has subsequently remained dry. The portion of the body operated upon has in general been immobilized in a plaster cast for 2 or 3 months after the implantation, and the cast has been fenestrated over the wound so that the latter could be observed carefully. The wound has been covered with a bandage only during the first few days after operation and afterward left exposed to the beneficial effects of sunlight and ventilation.

According to the results of my own investigations, implantation of os purum should be preferably done in cases of bone tuberculosis when the disease is in a quiescent stage and when the lesions have shown some tendency toward localization. Even in many cases of joint resection in more active forms of tuberculosis, however, os purum may give a good result. It is only in cases in which fistulas have formed, or in cases in which the overlying skin has been rendered thin and unhealthy by secondary infection or abscess formation that the implant is sometimes extruded. Considerable space would be required to review in detail the indications for operation, at least so far as surgical tuberculosis is concerned. These can be learned only through practical experience in the clinic where one may see for himself and follow the treatment and course of healing among the cases.

When one wishes to learn the technique of the use of os purum for implantations, he should begin with simple procedures. Later, after a survey of the results of these cases, he should pass on to more difficult problems. In this way uncertainty is eliminated and increasing trust in the use of os purum is acquired.

In using os purum, an especially careful aseptic technique is demanded, together with a few specially constructed simple instruments which have been described in previous communications.[1,2] Besides these instruments, it is advantageous to have wooden tampons (Fig. 14) for the introduction of the os purum into its bed. Sterilization of os purum is most easily accomplished by boiling in physiological

[1]Orell, Svante. Osteoplastic cuneiform osteotomy in the treatment of ankylosis. J. Bone & Joint Surg., 1932, 14: 643.
[2]Idem. Interposition of os purum in osteosynthesis after osteotomy, resection of bones and joints (Interposition-osteosynthesis). Surg., Gynec. & Obst., 1934, 59: 638.

sodium chloride solution; this, in addition, slightly softens the collagen in the os purum and perhaps makes it more easily soluble by the cells and tissue juices in the tissue bed. Since the os purum becomes somewhat soft in consistency after sterilization, wooden instruments spare the soft spongy framework more than hard steel instruments.

It must be remembered, in the use of os purum, that a good clinical result from its implantation may be expected only when skeletal connective tissue is present in the bed of implantation. Thus, in implants into the epiphysis large surfaces of cancellous bone must lie against the os purum, and in implants into the diaphysis, living periosteum as well as compact bone must surround it.

SUMMARY

In bone implantations, either fresh bone which contains connective tissue may be used, or a specially prepared bone introduced by the author and called "os purum," or the two may be used together. Cooked bone which has been dried, or bone which has been fixed in fixing solutions is not suitable for implantations. The use of os purum has the following advantages:

1. Since fresh autoplastic bone contains living bone connective tissue, it must be treated with great respect at implantation. Os purum, however, can be handled with much greater freedom and may be shaped in any manner best adapted to the situation provided it is sterile when placed in the tissues.

2. Os purum may be stored and kept over a considerable period of time, and a number of sizes and shapes may be prepared by machine beforehand. The form best suited for the portion of the skeleton which is to be repaired or reshaped may then be selected from among them.

3. No limitations as to size and shape are imposed, as is true when fresh bone is taken from the patient's own skeleton.

4. By using os purum in bone implantations, the accessory operation to obtain fresh autoplastic material is rendered unnecessary. The operative procedure is thereby shortened and simplified, and the risk for the patient is consequently lessened.

5. By implantation of os purum together with fresh autoplastic material, the more difficultly obtained material may be spared and good shape and filling still be attained in the injured or deformed skeletal part by the supplementary use of os purum.

A series of cases of tuberculous osteitis and osteo-arthritis is reported, together with a case each of bone cyst and osteitis fibrosa, in the operative treatment of which, os purum has been implanted in various ways. In these cases, os purum has healed in, as a rule, without complication and has had sufficient stability for its mechanical task until it has been gradually rebuilt and replaced by new bone.

DIABETES AND PREGNANCY

W. W. HERRICK, M.D., and ALVIN J. B. TILLMAN, M.D., New York, New York

IT IS now more than a decade since the use of insulin in the diabetes of pregnancy became general. A sufficient time has therefore elapsed for the collection of material upon which to base reliable estimates of its effectiveness. Among the many contributions to the subject in the literature, the most notable are those of Skipper, White, and Peckham. A body of opinion has been built up by these and other studies which may be given a brief review.

The disease may antedate or arise in pregnancy; it may be either mild or severe, and either badly or well controlled by treatment. Unquestionably, severe diabetes affects the reproductive function adversely. Menstrual irregularities or amenorrhea are almost the rule in severe diabetes, as are undernourishment and retarded development. The effect of this in reducing activity of the pituitary, thyroid, and reproductive glands is well known. A lack of estrin, a disappearance of graafian follicles and lack of genital development are described. It is the common experience that these deficiencies may be overcome by proper insulin treatment, and one result of such treatment is the greater fecundity of the victim of severe diabetes, a fact which complicates the problem of management during gestation and labor.

Diabetes with onset during pregnancy presents diagnostic problems for a number of reasons. The metabolic equilibrium of pregnancy is relatively unstable. In addition to the disordered carbohydrate metabolism there is an increased metabolic rate averaging 14 per cent in the last trimester, a diminished alkali reserve, a tendency to acidosis, a lowered plasma combining power of the blood for carbon dioxide, and a tendency to depletion of the glycogen store with resulting hypoglycemia. A lowered renal threshold for glucose is common in pregnancy, often associated with a lowered assimilation limit for carbohydrate. Even in the non-diabetic pregnant woman the blood sugar curve after the administration of 100 grams of glucose may approach or assume the "plateau" or diabetic form. In most cases these metabolic changes are temporary; in a few they mark the onset of diabetes. Often only after careful and repeated study of the sugar in the blood and urine is it possible to determine whether or not a given pregnant patient with glycosuria is really diabetic, and on occasion a follow-up study in the postpartum period may be necessary.

The requirements of the fetus create a demand for about 50 grams of additional carbohydrate each 24 hours in the later months of pregnancy. The possibility that the fetal pancreas and other glands of internal secretion supplement corresponding maternal mechanisms is not yet definitely proved. This may well introduce a further factor making for a disturbed physiological equilibrium.

As regards the infant, diabetes in pregnancy is almost if not quite as menacing as in the pre-insulin era. The fetal and infant mortality remains little changed and seems to vary directly with the severity of the maternal diabetes and the effectiveness of its control. An opinion widely expressed states that the children of diabetic mothers weigh at birth much more than the average. This has been said to lead to prolonged labors with attendant possibility of fetal or maternal injury. The explanation for this increase of fetal size is not clear, and the anomaly is said not to have varied since the administration of insulin. Theoretical speculations assign it to superalimentation, the consequence of maternal hyperglycemia or lipemia, to hyperplasia of the fetal islands of Langerhans, or to anomalous endocrine influences. That the increase is due largely to skeletal development and to fat brings up the question of the possible implication of the pituitary. The recent findings of Smith of a prolan-estrin imbalance in

From the Sloane Hospital for Women and the Departments of Obstetrics and Gynecology and of the Practice of Medicine, Columbia University.

TABLE I.—OUTCOME OF PREGNANCIES

Births	No.	Per cent
Living	38	56.7
Stillbirths, neonatal deaths, and spontaneous abortions	15	22.4
Terminated	14	20.7
	67	99.8

toxemias of pregnancy and in those pregnant diabetics who developed toxemia or who had either stillbirths or edematous giant infants adds further support to these theories.

The greatly increased liability to intrauterine death is typical of diabetes. The cause is not yet known. It may be associated with the vascular type of toxemia with hypertension, with hydramnios, or possibly with disturbed function of the endocrine glands concerned in reproduction. Hyperglycemia and ketosis definitely promote fetal death. Maternal hypoglycemia as a cause of fetal death seems unlikely. Skipper states that a moderate fetal hypoglycemia is frequent in diabetes.

The fetus is often macerated. No characteristic changes in the placenta have been described. Fetal anomalies are said to be much more common in diabetes, among these being monsters, congenital heart lesions, meningocele, mongolian idiots, and gastrointestinal atresia. We observed none of these in our series.

The question of the inheritance of diabetes is not yet settled. According to Joslin and associates, the disease tends to be transmitted as a recessive mendelian trait. More than one parent or hereditary carrier must therefore be concerned in its transmission.

PERSONAL OBSERVATIONS

As an addition to the body of the statistical and other studies on the subject, we present the experience of a large obstetrical clinic in the management of diabetes in pregnancy within the insulin era. During the first 14 years of this era, 56 patients with diabetes mellitus were observed in 67 pregnancies at the Sloane Hospital for Women. Of these, 40 patients were ward with 46 pregnancies, and 16 were private with 21 pregnancies. The outcome of the pregnancies is shown in Table I.

TABLE II.—FAMILY HISTORY

Maternal only	Pts.	Paternal only	Pts.
Diabetes alone	2	Diabetes alone	2
Diabetes with "heart trouble"	1	Diabetes with "heart trouble"	1
Diabetes with goiter	1	Diabetes in uncle, and relative, cerebral hemorrhage in father	1
Hypertension and asthma	1	Gangrene of foot, amputation	1
"Heart trouble" in mother and "kidney trouble" in sister	1		
Foot amputation, death	1		
	7		5

Maternal and Paternal in same family				Pts.
Diabetes	in father	and "heart trouble"	in mother	1
"Heart trouble"	in father	and diabetes, stroke,	in mother	1
"Heart trouble"	in father	and "heart trouble"	in mother	1
Stroke	in father	and "kidney trouble"	in mother	1
Nephritis in father and brother and stroke			in mother	1
				5

Among the diabetics in the Sloane Hospital the percentage of stillbirths from all causes was 28.0; this is in contrast with the percentage of stillbirths in all deliveries, which was 4.2.

Family history. The familial tendency to diabetes is well shown in the following tables. It will be noted that of 17 patients in whom a family history is known, 10 gave a history of familial incidence of diabetes: 3 in the father, 1 in a paternal uncle, and 6 in the mother. In addition to diabetes, 1 parent in 2 cases suffered amputation of a foot. Cardiovascular disease was strikingly frequent. The incidence might be even higher as a number of patients were entirely ignorant of their family history.

Personal history. The personal history does not suggest that infection is an important factor in the etiology of this group of cases. On the other hand, it is of interest that there were 5 cases of hyperthyroidism. The age range of onset of the diabetes was from 15 to 38 years, in 11 the age of onset being unknown and not determinable. It is a striking and perhaps exceptional observation that in none of these cases did the diabetes start before puberty. In 11, the diabetes definitely started in pregnancy.

The previous obstetrical history showed that an extraordinary number of these women had stillbirths, miscarriages, or infants that died immediately after birth. Of the 56 patients, 17 experienced 86 pregnancies in all, and of these, 49, or 57.0 per cent, terminated in stillbirth, neonatal death, or abortion. An increased liability to toxemia is also revealed by their history.

TABLE III.—PREVIOUS OBSTETRICAL HISTORY

Patient No	Gravidity	Pregnancies	Dead
7	11	First 6 fullterm living at birth; 1 postnatal death, 1 stillbirth, 3 miscarriages	5
8	2	Abortion, 3 months; fullterm stillbirth, 10 lbs.	2
5	4	First 3 babies, fate unknown; 1 fullterm died at 4 mos.; 1 stillbirth	1
11	6	All weighed 10 to 12 lbs.; 2 postnatal deaths, 1 stillbirth	3
13	8	2 stillbirths; 2 spontaneous abortions	4
16	4	Hard labors; all weighed 9½ to 12 lbs.; 1 stillbirth	1
21	8	Last 3 pregnancies stillbirths; weights 6½ to 10 pounds	3
27	2	2 stillbirths; last delivered by cesarean section	2
28	5	3 neonatal deaths, weighed 11 to 12 lbs.; 1 premature stillbirth	4
31	1	1 stillbirth	1
34	2	1 premature stillbirth; 1 abortion; diabetic coma	2
39	3	1 stillbirth at term	1
40	1	1 stillbirth, premature	1
41	6	3 miscarriages	3
43	5	4 stillbirths; premature twins, neonatal deaths	6
5 Spec.	7	7 stillbirths and neonatal deaths; no living children	7
12 Spec.	11	2 stillbirths, 1 abortion	3

TABLE IV.—GRAVIDITY AT FIRST DIABETIC PREGNANCY (SLOANE)

Gravidity	Cases
1	17
2	7
3	7
4	8
5	3
6	4
7	3
8	2
9	2
12	2
? (private)	1

TABLE V.—LIVING CHILDREN AT TIME OF FIRST SLOANE DIABETIC PREGNANCY

Living children	Patients
1	10
2	5
3	6
4	3
5	3
6	1
7	1
8	1
none	24
? (private)	2

TABLE VI.—HEIGHT AND WEIGHT OF DIABETIC PREGNANT WOMEN

	Weight								
Height	100	100–119	120–139	140–159	160–179	180–199	200	?	Total
5′		1	1						2
5′ 1″			2				1		3
5′ 2″		2	3	5					10
5′ 3″			1			1			2
5′ 4″		1					2		3
5′ 5″					3				3
5′ 6″				2					2
???	2	3	2	2	2		2	18	31

The gravidity of these patients when first observed at the Sloane Hospital and the number of living children at the time are shown in Tables IV and V. Seven of the childless patients were multiparas, the others, primiparas.

Table VI, giving height and weight, shows a tendency to shortness of stature in these diabetic women. There is not, however, a conspicuous preponderance of obesity.

COURSE AND MANAGEMENT

The antepartum complications in this series are of striking interest. Especially noteworthy is the great liability to late toxemia. In the 12 who evidenced a complicating toxemia, the blood pressure ranged from 150 to 180 millimeters mercury systolic, and 90 to 120 millimeters mercury diastolic, the average being 166 millimeters mercury systolic and 105 millimeters mercury diastolic. Albuminuria was either absent altogether or rose to 8 per cent before delivery. This striking association of diabetes in pregnancy with the vascular type of toxemia may have peculiar significance which will be discussed in a further paragraph. Other antepartum complications seem less important and are relatively infrequent.

The management of this group of diabetic pregnant women was not consistent. Some were private patients who were admitted for delivery only and had, therefore, incomplete hospital records. Others were emergency admissions for delivery only. There was a group of unco-operative patients whose care had

TABLE VII.—FETAL DEATHS

Patient No.	Antepartum care	Cause of fetal death	Comment
3–11774	None	Diabetes?	Abortion. Emergency admission. Not registered in Sloane Hospital
6–10024	1 month	Diabetes	Premature, 7 mos.; neonatal death
7–81820	None	Prolapsed cord	Admitted at term. Full term stillbirth
9–86392	Unco-operative	See comment	Complications: lues, toxemia, fibroids, diabetes, premature separation of placenta
10–85674	Throughout	Bandl's ring	Antenatal death; craniotomy
19–271202	Unco-operative	Diabetes	Neglect on part of patient. Treatment in 7th month, then none until admitted for delivery
22–472118	Elsewhere adequate?	See comment	Complications: hyperthyroidism, large fibroids, diabetes. No diabetic treatment in Sloane. Admitted for delivery only.
23–450781	Adequate	Fibroids	Spontaneous abortion. Multiple fibroids, hysterectomy advised
35–10033	None	Diabetes	Emergency admission, premature birth, neonatal death, impending coma
30–5644	None	Diabetes	Complications: lues and diabetes. Full term macerated stillbirth
36–10327	Private	Diabetes	Diabetes apparently controlled. Fetal heart disappeared during actual delivery. Poorly developed full term infant weighing 1,490 gms.
39–456755	Private	Unco-operative see comment	Complications: hypertensive cardiovascular disease, overweight, diabetes not controlled, stillbirth
40–4040	1 month	Diabetes	Premature stillbirth. Diabetes not controlled
43–489946	Private-none	Diabetes	Spontaneous abortion. Acidosis on admission. Diabetes not known of until patient was admitted in coma
37–456725	Private inadequate care	Diabetes	Acidosis. Cesarean section (flat pelvis) macerated stillbirth, term

been inadequate for this reason. Only 21 patients had been managed for adequate periods, by the accepted methods at the Sloane Hospital. These periods varied from the full 9 months of gestation to a minimum of 2 months.

The fetus. In this series there were 11 stillbirths and neonatal deaths and 4 spontaneous abortions. The causes of these accidents are set forth in Table VII.

With regard to the size of the fetus of the diabetic mother, our experience, as illustrated by the accompanying graph showing viable births, does not bear out commonly accepted ideas. The graph shows that the child of the diabetic mother is as likely to be underweight as overweight. Of the viable births 12.2 per cent were underweight and 26.5 overweight. Among the babies of an equal number of unselected normal mothers 18.0 per cent were overweight. In the zone of weights between 5 and 8½ pounds there seems to be a slight preponderance of large babies in the group of normal as compared with diabetic mothers.

In our series, 41 were delivered normally or by means of forceps. Of these, 11 were stillbirths or neonatal deaths, 5 premature and 6 at term. The mode of delivery in the 11 was normal in 5, by forceps in 5 and cesarean section in 1. In 5 of the stillbirths the fetal weight was 5 pounds or less; in 3, from 8 pounds 14 ounces to 11 pounds 11 ounces. Two of the deaths were due to obstetrical causes, namely, prolapsed cord and Bandl's ring; 1 was due to toxemia.

Treatment. During pregnancy the diabetic patient presents several therapeutic pitfalls. The vomiting of early pregnancy augments the danger of diabetic acidosis, so that a serious ketosis may develop rapidly. In some such cases abortion may occur before coma. For this reason the regulation of diet and insulin in the first trimester may be difficult or even impossible. Here a high carbohydrate intake is best adapted to the treatment of both the ketosis of diabetes and the vomiting of pregnancy.

Regardless of the previous diet of the patient, it has been our general practice to attempt to supply 200 grams of carbohydrate daily to the diabetic patient with vomiting of pregnancy. This is given in 5 or 6 feedings at 2 hour intervals and insulin is given as often as indicated by the results of urinalysis and

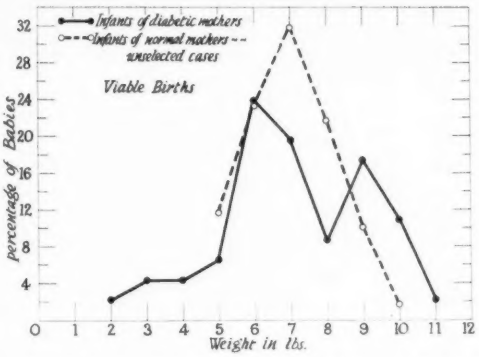
the determination of the sugar and the carbon dioxide combining power of the blood. Until the vomiting is under control, no attempt is made to supply protein or fat excepting such as may be present with the administered carbohydrate.

The next step in management is the building up of a more normal diet in which the number of calories per kilogram varies inversely with the weight of the patient. The adverse effect of obesity upon diabetes must be regarded. Furthermore, the overweight patient has the added risk of toxemia of pregnancy and in our experience an increased fetal mortality. In the obese, no measure seems to us of more importance in reducing maternal morbidity and fetal mortality than loss of weight during gestation. Even in the undernourished patient an attempt is made to limit the gain of weight during pregnancy to 25 pounds.

In the second trimester, once regulation has been established, there is generally little change in the basic requirements of diet and insulin. In 3 of our patients, however, tolerance decreased, and quite abruptly. This emphasizes the importance of a strict watch over the patient in this period, at intervals of not more than 7 to 10 days.

Between the sixth and ninth months marked changes in tolerance are to be expected. These vary in degree and in time of appearance with the individual patient. For this we lack an adequate explanation. In our series the charts of 20 patients gave data sufficient to permit evaluation of tolerance. In 9 of these there was very definite improvement as term approached, but in 7 there was just as marked a decrease in tolerance. This fact is very important in therapy. Only 4 of our patients showed an apparently unchanged tolerance throughout pregnancy. Decline in tolerance over a short period of time, if not promptly treated, may result in destruction of the fetus. It is important to remember that normal laboratory findings are not a guarantee that the diabetes will remain under control.

With regard to the fetus, hyperglycemia and acidosis are a greater threat than hypoglycemia. Of 5 patients with acidosis, 4 bore macerated stillbirths or miscarriages. Four-



Graph showing viability and weight of babies of diabetic mothers.

teen of our patients had hypoglycemic reactions, some reaching coma. The time of these reactions with reference to gestation was from the second month to the day before delivery. All these 14 patients bore living babies. In view of these observations we are inclined not to be unduly concerned in the presence of maternal hypoglycemia.

An increase in tolerance for glucose is often noted at the time of labor. As has been pointed out by others, this may result from the increase in activity of voluntary muscles and from uterine contractions. The insulin requirement of a given patient is often reduced materially at this time, a circumstance calling for a reduction in its dosage in order to avoid possible hypoglycemic reactions during labor. It is our practice to decrease by half the initial dose of insulin at the onset of labor, giving additional insulin as indicated by the results of study of the sugar of the urine and blood and the carbon dioxide combining power. In 2 patients with hypoglycemia in labor, the fetal blood taken at the same time showed an extremely low level of sugar. Clinically, however, these infants behaved normally and showed no evidence of hypoglycemia.

Labor and puerperium. Labor and the puerperium give rise to peculiar problems in the diabetic. Labor is critical. Anesthesia, especially with ether or chloroform, tends to induce coma. The exertions of parturition have a like effect in reducing the reserve of

TABLE VIII.—MODE OF DELIVERY

	No.
Spontaneous	25
Instrumental	16
Cesarean section	8
Dilatation and curettage	10
Hysterotomy and sterilization	4
Spontaneous abortion	5
	67

glycogen and alkali, thus promoting hypoglycemia, acidosis, and its consequences.

In our cases the hazard of infection seems to be as pronounced as in those reported elsewhere. There was a puerperal morbidity of 41 per cent, as judged by our standard—a temperature of 100.4 degrees for two consecutive readings after the first 24 hours following delivery. This diagnosis was made in 14 without any specific infection having been recognized. Two were diagnosed as endometritis, 1 as pyelitis, 1 as thrombophlebitis and 2 breast abscess.

Delivery. The mode of delivery in the 67 pregnancies is shown in Table VIII. Of the 67, 31 were delivered at term, 17 were premature, and 2 were overdue.

Among the 15 fetal deaths in both groups are included the spontaneous abortions. Of the 9 fetal deaths in the first group we consider diabetes the sole cause in 6. In the remaining 3 there were additional factors such as fibroids, lues, toxemia, and obesity.

In the second group, that of adequately controlled diabetics, 6 fetal deaths occurred. Two were premature stillbirths. In 1 case there were multiple fibroids; in another, fibroids and hyperthyroidism; in the 2 remaining, Bandl's ring and prolapsed cord. It will be noted that when fetal death occurred in diabetics adequately controlled a factor other than the diabetes was present.

Cesarean section. The question of cesarean section in diabetes is of special importance. It should have discussion from the standpoint of the mother and of the fetus. In none of our cases was cesarean section undertaken because of the diabetes alone. The indications for the operation in these patients were: for pelvic disproportion, 3; elective, following stillbirth caused by Bandl's ring in a previous pregnancy, 1; for uterine inertia, 1, followed by a second section in the same patient in a later pregnancy; for sterilization, 2.

Our experience inclines us to hesitancy in advising termination of pregnancy by cesarean section in the diabetic. In the first place, if this measure were adopted generally in all cases in which the diagnosis of diabetes in pregnancy might be made, a way would be opened to the commission of numerous errors. Among possible mistakes, that of diagnosis is not unimportant. Without adequate experience and laboratory equipment examples of renal glycosuria, lactosuria, or non-diabetic acidosis in pregnancy may be mistaken for true diabetes and the patient subjected to needless surgical hazard.

Since we have had no maternal deaths in diabetes during pregnancy, the puerperium, or the follow-up, we can find no strong argument for radical methods of delivery in this disease, at least from the standpoint of maternal security

At this point one might recall the fact that the general maternal mortality for this operation as given by P. H. Bland[1] is 6.5 per cent.

These facts tend to discourage the early or artificial termination of pregnancy as a general measure in diabetes.

The fact that a diabetic mother loses her fetus is not necessarily proof that the metabolic disorder is responsible for the unsuccessful pregnancy. In all such instances one should investigate such frequent causes of fetal death as toxemia, lues, hyperthyroidism, vitamin deficiency, uterine fibroids, or hormonal defects, any of which may be coexistent.

On the side of the fetus cesarean section is a more debatable matter. Can this operation diminish the frequency of fetal death in diabetes? Since it has been stated that the obstetrician's answer to diabetes is cesarean section shortly after viability to save the child, the ordinary fetal risks of this procedure might be recalled. It should be considered that every baby delivered by this dictum is premature. In a review of 300 cases of prematurity, Wilcox reports a gross mortality of 25 per cent regardless of the method of delivery. Without interrupting the pregnancy in the interests of

[1]Surg., Gynec. & Obst., 1937, 64: 338.

the child in advance of term, the total mortality in our cases was 28.3 per cent. Included in these figures are 4 spontaneous abortions in 9 inadequately treated diabetic mothers, and 4 with serious added obstetric complications such as Bandl's ring, prolapsed cord, and large fibromyomas. Excluding cases of this kind the corrected mortality is 3.7 per cent, a figure differing little from that of the general hospital admissions.

SUMMARY AND CONCLUSIONS

In an experience with the care of 56 patients with diabetes in 67 pregnancies we have been impressed with certain phases of the condition. In the first place, a family history of diabetes occurred in 17.8 per cent. Of equally common occurrence was a family history of vascular disease.

In none of the patients did the disease begin before puberty, so far as we could ascertain. In 15 cases, a larger proportion than is usually reported, the disease began during pregnancy.

The past obstetrical history is striking. There is a story of repeated stillbirths, abortions, and neonatal deaths. The reproductive capacity of these patients is low. The incidence of vascular disease and hyperthyroidism is high.

Under the conditions of a well organized clinic, the diabetic mother may be carried through pregnancy with little added risk. Further, there is a reasonably good chance of a viable infant provided the maternal care is adequate. Conversely, the fetal mortality in diabetes not adequately supervised and treated remains high. The striking liability of the diabetic woman to late toxemia should be emphasized. This seems a significant association. The internist has long surmised that vascular disease with hypertension is related to diabetes, and has noted the tendency of diabetes and hypertension to dwell in the same individuals and families. Further, the relation of late toxemia of pregnancy to vascular disease has been established. For this reason, the frequent association of diabetes with the vascular types of pregnancy toxemia is of more than casual significance.

The fetus of the diabetic mother is quite as likely to be underweight as overweight.

In our judgment the routine performance of cesarean section in uncomplicated maternal diabetes is unwise. This operation should be reserved for those cases in which there is a supporting obstetric indication.

REFERENCES

1. Peckham, C. H. Bull. Johns Hopkins Hosp., 1931, 41: 184.
2. Skipper, E. Quart. J. Med., 1933, 2: 353.
3. Smith, O. W., and Smith, G. Van S. Am. J. Obst., 1937, 33: 365.
4. White, Priscilla. Surg., Gynec. & Obst., 1935, 61: 324.

THE UPPER PELVIC FLOOR AND ITS IMPORTANCE IN TOTAL ABDOMINAL HYSTERECTOMY

LILIAN K. P. FARRAR, A.B., M.D., F.A.C.S., New York, New York

IN 1888 von Bardeleben, of Jena, reviewed the literature pertaining to gynecology from the time of Leonardo da Vinci ("*Der Alteste Median Schnitt*") up to and including his own period and characterized the writings "with few exceptions" up to the middle of 1800 as "*so gut wie nichts.*" He states that in the year 1854 there were published three papers by three different physicians, each in a different country which laid the foundation of gynecology. Kohlrausch published in Leipzig *Zur Anatomie und Physiologie der Beckenorgane.* He said that the position of the uterus was dependent upon the fullness of bladder and rectum, and that the cervix was fastened to the bladder by a light reticular plane of connective tissue. The second paper was printed in the *Gazette médicale de Paris* and was an exposition by Cruveilhier on the autopsy of a young woman who had died following the repeated use, for several days, of an indwelling catheter introduced into the uterus to correct a sharp anteflexion. Cruveilhier said that disease produced malposition of the uterus but that malposition existed without symptoms and did not produce disease. In the discussions with Arvard at this time, Cruveilhier gave his opinion, based upon autopsies, that there was no established normal position for the non-pregnant uterus. Arvard, who had palpated and moved the uterus in the living, and found that it would immediately return to position, claimed that an angle of 75 degrees with the horizon was the normal position for the uterus. The third paper was written by Matthews Duncan, and appeared in the *Edinburgh Medical and Surgical Journal* of that same year. It was entitled "On the Displacement of the Uterus." Duncan affirmed that, "Death was not a good criterion as so much depended upon muscular tonicity and vascular turgescence which disappeared with life." Duncan also wrote: "A uterus that is not mobile is in a pathological state." This is the beginning of the study of anatomy, physiology, and pathology of the pelvic organs in women.

In the *History and Bibliography of Anatomic Illustrations* written by Ludwig Choulant he writes: "The great universal genius Leonardo da Vinci illustrated the fetus in its natural position from direct personal observation and not until William Smellie in 1754 and William Hunter in 1774, both of London, published their monumental volumes do we actually find illustrations of the fetus *in utero* which were really observed and faultlessly reproduced from an anatomical point of view." There are even fewer illustrations of the non-pregnant uterus, but da Vinci has one showing graphically the blood vessels of the uterus, and Versalius has one plate in his work on the human body of the fusion of the muellerian ducts, and the uterus complete with the cervix, vagina, and urethra. In 1754 William Smellie published with the set of anatomical tables his "*Practice of Midwifery.*" In this work is one illustration of real historic value in gynecology as it shows the uterus supported on the vagina as it was at that time commonly believed to be. It is of interest to note that the artist (Pieter Camper) drew the course of muscle fibers from vagina to broad ligament. These colpovaginal muscle fibers were not utilized in plastic work on the vagina until more than a hundred years later.

While so little was done for gynecology by the anatomists immediately following Smellie, the study of pelvic conditions in women was greatly stimulated by the publications of Kohlrausch, Cruveilhier, and Duncan. The greater part of the research was done on frozen sections and naturally to a much less degree on the living. The reports were so at variance that Marion Sims wrote: "I would say therefore that some of the discrepancies of the

Presented before the American Gynecological Society, May 31, 1937.

authors may be reconciled when we remember that one speaks of the condition of things in the living subject and another in the dead. The knowledge of one is gained in the clinic, of the other in the dissection room." It was then that Henle wrote that deductions based upon frozen sections were of no value as both the consistency and the position of the uterus were altered after death, for in life the tone of the muscles and the filled blood vessels were of importance in establishing the position of the uterus.

In 1863 Luschka described the organized muscle fascia rich in elastic tissue that makes up the broad ligaments together with the many blood vessels and lymphatics in the lower part of the ligaments. He traced out the formation of the muscle fibers from the folds of Douglas to their insertion in the lower end of the uterus and vagina which "helped to fix the position of the uterus," and called these ligaments the "retractor uteri." Virchow demonstrated later that many of the muscle fibers in the uterosacral ligaments extend along the sides of the uterus and join with muscle fibers from the anterior face of the uterus to make up the thin layer of muscle in the uteropubic fascial plane on which the bladder rests. The position and axis of the uterus continued to be the subject of discussion and debate.

It was in 1880 that Kocks when a *Privatdozent* in the University of Bonn, wrote his monograph in which he discussed the normal and pathological position and shape of the uterus, and its mechanics. In this discussion, today a classic in gynecology, Kocks described the positions of the uterus, answering the arguments for and against the various displacements as found in frozen sections or as found on palpation in the living. His opinion was that the uterus has no absolute, but a relative, position. His arguments against the positions as found at postmortem, are that in the living (1) there is a positive abdominal pressure, (2) that the influence of inspiration and expiration must be considered, (3) in the ligamentous apparatus of the pelvic organs the connective tissue which binds them together has a certain degree of "turgescence" which is lost after death, and finally (4) the

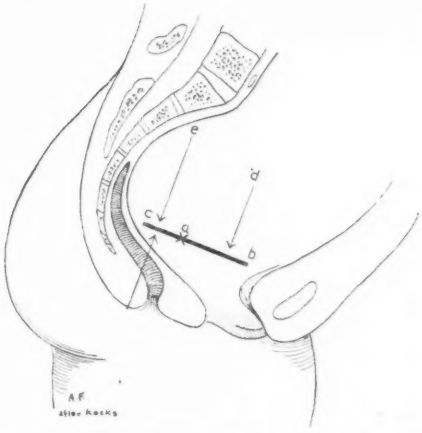


Fig. 1. Cardinal transverse horizontal axis. (From Kocks.)

muscle elements in the ligaments act with sufficient force in the living to influence the position of the uterus.

Kocks described the mechanics of the pelvis and says, "The bases of the broad ligaments build the axis of the uterus and because of their importance should be called the cardinal ligaments. They build, according to my thinking, the material 'substrat' of the axis and account for the normal anteversion of the uterus." He called the base of the broad ligaments the "cardinal transverse horizontal axis" and said on this axis the uterus turns as on a lever with two arms (Fig. 1). The anterior longer arm (*a-b*) is the position of the uterus in young women or in nulliparæ. The posterior shorter arm (*a-c*) is the position of the uterus after pregnancy has occurred. The uterus then has a longer axis upward due to its increase in size and sinks lower toward the vaginal outlet as a result of the softening of the pelvic tissues, and it is not as sharply bent forward as in a nullipara. The intra-abdominal pressure is greater on the axis *a-c*, but may be equal in both axes under certain conditions.

In a summing up of the position and mechanics of the uterus, Kocks gives such an exact and concise description, I will quote in its entirety. He says: "The upper pelvic floor consists of the bases of the broad ligaments,

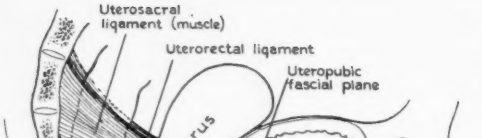


Fig. 2. Uterosacral ligaments, uteropubic fascial plane, and the levator ani muscle.

the uterine end of the ligamentum sacro-uteri, the ligamentum vesico-uteri, the posterior wall of the bladder, and the anterior wall of the rectum, all of which are bound together by connective tissue fibers and covered with peritoneum and inserted into the uterus at the height of the internal os. The finger thick bases of the broad ligaments form the true lever (*Drehpunkte*) for the mechanics of the uterus."

Two years after Kocks' monograph, Berry-Hart of Edinburgh published his atlas and at about the same time Savage, of London, brought out his beautifully colored plates of the pelvic organs in women. Berry-Hart described the fibromuscular tissue of the uterosacral ligaments as alike in structure with the broad ligaments with which they are joined, differing only in the greater proportion (Fig. 2) of muscle in the uterosacral ligaments and in the great amount of elastic tissue throughout the broad ligaments and the connective tissue at their base. The uterosacral ligaments have at their upper border a flat fold of muscle fascia that extends from the uterus to the rectum, and if one wishes to be anatomically correct they should be called uterorectal ligaments. The true uterosacral ligaments lie just below these two folds and extend (on each side of the rectum) from about the third sacral vertebra to be inserted into the posterior surface of the uterus at the height of the internal os. This insertion of the ligaments extends down the entire posterior cervix and then down to be inserted into the posterior wall of the vagina. It is due to the thickness of these muscles and to their insertion into the posterior cervix and vagina that the uterosacral ligaments become the strongest factor in the upper pelvic floor that influences the position of the uterus. Luschka rightly termed them the "retractor uteri."

The elastic tissue in the broad ligaments allows of movement of the tissues themselves and of displacement of the uterus laterally or posteriorly or for growth of the uterus upward without disturbance or injury of the structures within the broad ligaments. The anterior portion of the upper pelvic floor is composed of light reticular fascia and the uteropubic fascial plane on which the bladder rests is made up of connective tissue with only a thin layer of muscle and almost no elastic tissue. It is for this reason that the powerful muscles in the uterosacral ligaments can influence the position and direction of the descending head in labor as proved by x-ray studies made by Caldwell and Moloy. It is also the reason why the most common and often the only visible injury after labor is a resulting cystocele due to the pressure on the uteropubic fascial plane which splits longitudinally and its torn edges (so erroneously called the "pillars of the bladder") stretch apart from the continued intra-abdominal pressure. The bladder forced by prolonged pressure from above slips through the gap in the torn fascial plane just as a loop of intestine does in a hernia.

The connective tissue in the base of the broad ligaments was well described first by Savage who wrote: "The uterine system may be conceived as having been thrust into the pelvis between the rectum and bladder and there fixing itself by cellular attachments to every available part of the pelvic cavity." Savage was also the first to note that infection in the broad ligaments long remained local without involvement of the ureter, rectum, or bladder. He also showed that the uterine cellular system is continuous at its periphery with every part of the subperitoneal cellular tissue at the lower part of the abdomen.

The beautiful illustrations in the atlas by Sappey of his work on the lymphatics of the body depict the glands lying in the broad

ligaments and the course of the lymphatics from the uterus. The importance of removing these glands in the broad ligaments was stressed by Wertheim when performing hysterectomy for cancer of the cervix.

In 1885 Freund published his work on the connective tissue of the pelvis and the result of an inflammation that involves it, and Testut later described the "phlegmons" or abscesses of the broad ligaments with the four routes of approach: (1) Vaginal route—by incision direct without opening the peritoneum; (2) perineal route of Hegar and Saenger that crosses the ischiorectal fossa and levator ani; (3) parasacral route of Zuckerkandl and Wolfer and is made at the border of the sacrum upon the sides of the rectum; (4) abdominal *sous peritoneale* of Pozzi.

The sympathetic ganglia lying on the posterior leaves of the broad ligaments had been demonstrated as early as 1867 by Frankenhauser; their location he believes accounts for the fact that operations on the posterior pelvis produce more shock than operations on the anterior pelvis. Undoubtedly this fact explains why less shock is associated with a vaginal hysterectomy than with an abdominal hysterectomy for in vaginal hysterectomy there is not nearly so great an invasion and injury by clamps to the broad ligaments as there is in the abdominal operation.

In 1894 Mackenrodt, of Berlin, wrote concerning the normal and pathological positions of the uterus and he described the tissues of the broad ligament which he called the *Ligamentum transversale colli*. This ligament (*band*) has been the subject of much discussion and several papers have been written denying its existence, the reason being, I believe, a misconception of Mackenrodt's use of the word *band*. The illustration published in the same issue of the *Archives fuer Gynaekologie* certainly leaves no doubt that Mackenrodt intended the entire broad ligament as the *Ligamentum transversale colli*. Mackenrodt's exposition of the tissues in the broad ligament adds nothing to the work of the previous writers but is of value inasmuch as he maintains that the broad ligaments are the supporting structures of the uterus. The objection is often made that the tissues described by both Kocks and Mackenrodt are not true ligaments, and this may explain why their studies have not received more recognition.

In 1899 Waldeyer, of Berlin, in his great work *Das Becken* showed by illustrations the embryological and anatomical formation of the structures composing the broad ligaments: (a) The three ligaments that lie on each side of the uterus in the folds of the broad ligaments begin early in embryological life as two strands of tissue that cross (one on each side) the muellerian ducts. Later in fetal life having derived muscle from the outer coat of the uterus, the anterior portion of each strand of tissue becomes a round ligament, similar to the "gubernaculum" of John Hunter, and composed of muscle and elastic tissue in its upper half and of connective tissue in the lower half where it is attached to the pubic bone and labia majora. Berry-Hart, in his interesting work, has traced the physiological descent of both the ovaries and testes in the human fetus and says the descent of the ovary is analogous to that of the testes, but its further descent in the pelvis is checked by the broad ligament and the uterus. In the adult female, the ovaries lie on the posterior aspect of the broad ligament, on the lateral pelvic wall in front of the sacro-iliac joints, immediately below the ileopectineal line, and with the ureter curving behind. The pelvic ectopia testis is analogous to the normal position of the ovaries. The inguinal and lateral ectopia ovarii are normal stages for the testes. Waldeyer showed that the upper part of the strands of embryonic tissue take their muscle from the uterus and are continued as the ovarian ligament and then as the infundibulo pelvic ligament. If the ovaries are to be left *in situ* when a hysterectomy is performed, the ovarian ligaments (by virtue of this muscle) should be fastened to the vaginal or cervical wound before it is closed.

Luschka (in 1863) first called attention to the proximity of the ureter to the ovary just as the ureter is about to enter the broad ligament where it lies superficially under the posterior leaf of the broad ligament to which it is attached. The ureter continues directly under the hilum of the ovary to which it is often adherent and as it emerges from the broad

ligament lies close to the vaginal plexus of veins. The origin of the base of the broad ligament is shown by Waldeyer to be from the uterus at the height of the internal os. The muscle is derived from the outer muscular coat of the uterus as shown by Pietro Sue (in 1600). Its fibers extend from the uterus transversely and obliquely to the pelvic wall, and laterally are continuous with the adjacent tissues. There is no line of demarcation between this muscle and the uterus and no attachment of the broad ligament to the uterus as it is sometimes stated in textbooks. The connective tissue sheaths of veins, lymphatics, blood vessels, and ureters run more or less obliquely from back forward and from above downward through the broad ligaments strengthening them but not fixing the tissues rigidly, for the great amount of elastic tissue present in the folds of the ligaments permits considerable movement of these sheaths and allows for the growth of the uterus upward in pregnancy or for lateral or posterior displacements of the uterus or for its enlargement by tumors.

An excellent description of the external appearance of the broad ligament is given by Testut who says: "The broad ligament consists of two folds of peritoneum as they leave the sides of the uterus in close apposition one to the other for a part of the distance to the lateral walls of the pelvis. They form a sheet of tissue irregularly quadrilateral the upper border of which is free, thin, and mobile, the other borders of which are thick and attached to the lateral wall of the pelvis and to the upper pelvic floor and to the sides of the uterus. This sheet of tissue forms on each side of the uterus—two wings to the uterus, as it were, and consists only of the broad ligaments. (a) The anterior face of the broad ligament looks forward and downward; (b) the posterior face, which is larger, looks backward and upward and envelops part of the ovary and its ligament, the mesosalpinx and the hooded cap of the ovary; (c) the superior border encloses the fallopian tube, ovary, and its ligaments; (d) the inferior border, the thickest of the four borders, rests on the upper pelvic floor. (It is in close contact with the lateral cul-de-sac of the vagina. It contains the ureter and the horizontal part of the uterine artery); (e) the internal border, thick and short, rests at the side of the uterus, it contains the ascending part of the uterine artery and the venous plexus; (f) the external border, relatively thin, rests at the lateral wall of the pelvis. In the upper part between the pavillon of the tube and the external extremity of the ovary it is free and *flottant*. Below the ovary it adheres closely to the pelvic wall near the obturator internus and its aponeurosis and at the extremity of the ovary it continues as the infundibulopelvic ligament, the ilio-ovarian ligament, or the lumbar ovarian ligament. It lodges the ovarian artery and vessels and contains smooth muscle (Luschka's 'retractor of the fallopian tube'). It crosses the iliac vessels, then the border of the psoas muscle to the lumbar region. Anatomically the broad ligament is composed essentially of two leaves of serous tissue with a sheet of smooth muscle united one with the other by a bed of cellular vascular tissue. A sagittal section shows it consists of: (a) the meso-salpinx—two leaves of peritoneum, between which is a bed of cellular elastic tissue and some blood vessels; (b) the base of the broad ligament—lymphatics, cellular tissue, blood vessels."

The relation of the structures in the broad ligaments to one another and to the adjacent structures is shown in an admirable dissection (Fig. 3) made by Sellheim. Comparative anatomy of the female pelvic organs has seldom been described and never more beautifully illustrated than in his dissections (Fig. 4). If we bear in mind, as Blair Bell has said, the important fact that there are no aponeurotic fascias except in relation to muscle surfaces (Fig. 5) and that when fascia comes into relation with blood vessels, lymphatics or nerves, it forms fibrous bands and sheaths. This increases the supporting power of the structures in the broad ligaments. Add to this the fact that the levator ani (Fig. 6) arises from the back of the pubic bone and the fascia on the internal surface of the compressor urethræ with which its fascial coverings are blended, that its superior fascial covering is attached to the aponeurosis of that of the muscles above, and posteriorly its aponeurosis is adherent to the ischial spine and continues to the side and anterior surface

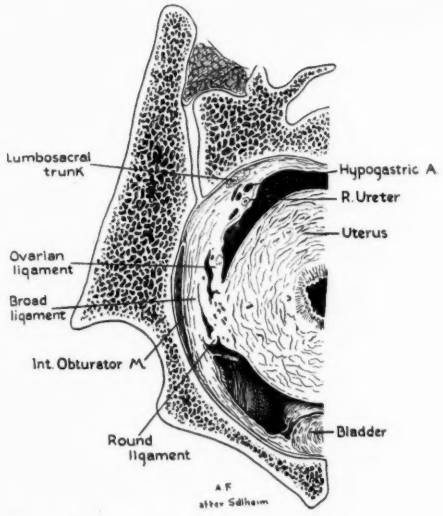


Fig. 3. Cross section at about the first sacral vertebra showing the broad ligament and its relation to the obturator internus muscle, etc. (After Sellheim.)

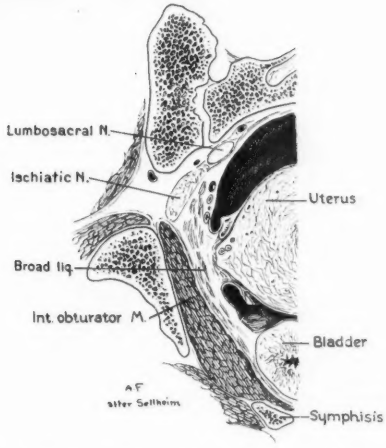


Fig. 4. Cross section 2 centimeters below that in the preceding illustration showing the broad ligament and its relation to the obturator internus muscle and the sheaths of the nerve trunks. (After Sellheim.)

of the coccyx where the fascias from either side unite in the midline. Thus the whole upper floor forms a united structure for the support of the uterus.

The tissues in the broad ligament vary greatly even in young women, depending upon the age, general constitution, and muscular development. Their vascularity and elasticity are greatly increased during pregnancy. In the normally developed young woman and in

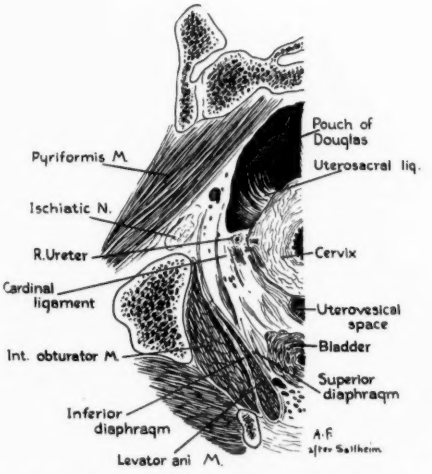


Fig. 5. Cross section 2 centimeters below that in the preceding illustration showing the cardinal ligament and its relation to the pyriform, internal obturator, and levator ani muscles, the sheaths of nerves, ureter, and blood vessels. (After Sellheim.)

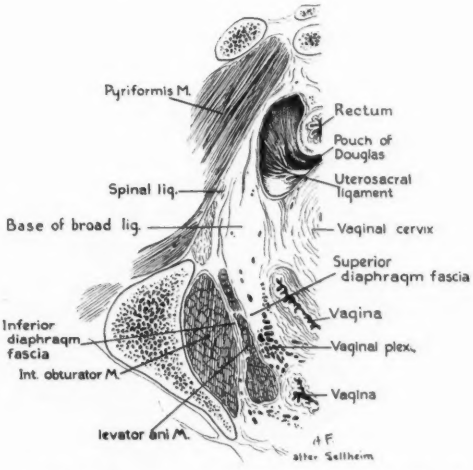


Fig. 6. Cross section 2 centimeters below that in the preceding illustration showing the base of the broad ligament and its relation to the pyriform and levator ani muscles, the spinal ligament and the uterosacral ligament. (After Sellheim.)

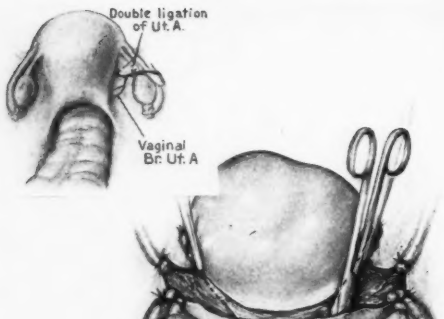


Fig. 7.

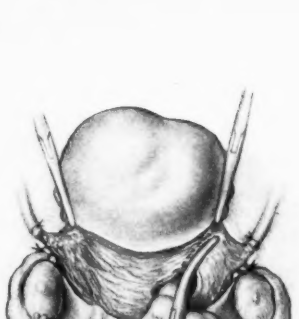


Fig. 8.

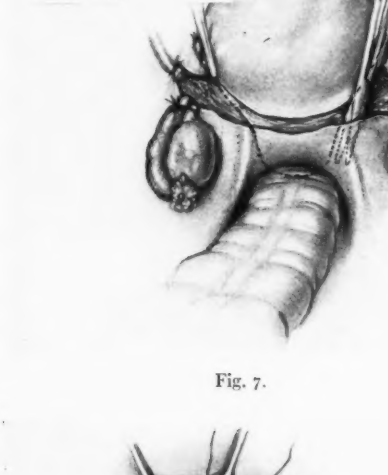


Fig. 9.

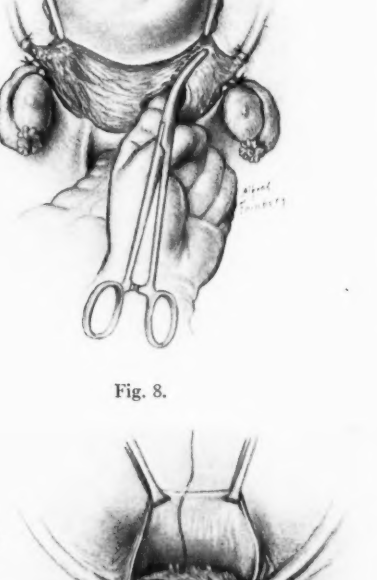


Fig. 10.

Fig. 7. Uterine artery ligated at entrance into lateral wall of uterus and again beyond origin of vaginal branch from uterine artery. Scissors cutting down sides of uterus—*no clamps*.

Fig. 8. Finger introduced through the opening made into vagina to apply an artery clamp close to side of uterus before cutting out uterus.

Fig. 9. Sewing the round ligaments to the sutured vaginal wound.

Fig. 10. Sewing uterosacrals to round ligaments and uteropubic fascial plane.

nulliparæ the broad ligaments are soft, firm, and only moderately yielding to pressure, unless examined when the individual is under an anesthetic. In multiparæ the tissues are thicker and less resistant. In the aged the muscles are much thinner and the uterus is more readily displaced downward, due not always to torn muscle, but as well to the loss of the very large amount of elastic tissue normally present in younger women. If fibroids have developed in the uterus, the tissue of the broad ligaments may have the same firmness as the uterine tissue and when taking out such a uterus in an abdominal hysterectomy it may be as hard to cut as gristle. The effect of inflammation or suppuration in the parametrium may be to leave a chronically thickened tissue across the base of the upper pelvic floor. The development of connective tissue and its supporting effect may be seen after the radium treatment of a cancer of the cervix; the vault of the vagina may become narrow in width and much thickened with no prolapse of the now shrunken cervix, although perhaps below the irradiated tissues a gaping vulvar orifice with a large cystocele and rectocele bulging into the vagina may be seen. From all this it is plain that the development and character of the tissues in the broad ligaments vary greatly in the living, depending not only upon age and constitution but also upon the effect of injuries incident to labor, of loss of muscular tone and elasticity, and to inflammation or tumor growth. All of these factors should be taken into consideration before an operation is undertaken. As von Bardeleben said many years ago: "Anatomy is not the knowledge of a cadaver, nor of dead tissues, but it is a part of the knowledge we have of the living."

It was not until nearly the end of 1800 that surgeons began to use the paracervical and paravaginal tissues in repair of prolapse of the uterus. In 1887–1888 Ernst Cohn, of Berlin, published the results obtained by Schroeder and Olshausen who in such cases performed anterior or posterior colporrhaphy and in a few cases the combined operation, of anterior and posterior colporrhaphy. In 1888 Archibald Donald, of Manchester, England, for the first time, amputated the cervix and then did an anterior and posterior colporrhaphy on the same patient. Donald published his first report in 1902, and in 1903 Alexandroff, of Smolensk, Russia, described his technique of bringing the base of the broad ligaments from either side of the cervix and suturing them to one another and to the anterior surface of the cervix. It is of further interest that in the years 1907, 1908, 1909, surgeons of different countries should so nearly duplicate their knowledge and use of these tissues in prolapse. In 1907 Halban and Tandler published their work on the anatomy and etiology of genital prolapse in women; they stated that the levator ani and the associated muscles are the essential factors in keeping the uterus in place. In 1908, Fothergill, of Manchester, who has continued to practice the technique first used by Donald and now called the technique of the Manchester School, wrote "The Supports of the Pelvic Viscera." In a later paper Fothergill said: "Clinical experience gradually taught me that the uterus, vagina, and bladder are mainly kept in their place by the lateral combination of unstriped muscle and connective tissue known as the parametrium and the paracolpos." One year later William Mecklenburg Polk presented an address before the American Gynecological Society entitled "The Suprapubic Operation on the Upper Pelvic Floor for Prolapse of the Uterus." Since then two other members of this society namely, Robert L. Dickinson and Robert T. Frank have contributed much to our knowledge of the supporting tissues of the upper pelvic floor.

It is important therefore in total abdominal hysterectomy, to avoid, so far as possible, injury to the structures that lie in the depths of the upper pelvic floor and to utilize the supporting tissues in closure of the wound. First, hemorrhage from the vaginal venous plexus may be avoided by ligating the uterine artery, not only where it enters the uterus, but also before the vaginal and cervical branches are given off from the uterine artery. Second, injury to the sympathetic ganglia lying on the posterior leaf of the broad ligament may be avoided by cutting down the broad ligaments close to the sides of the uterus without applying any clamp to the broad ligaments (Fig. 7). Third by cutting the uterosacral muscles and

entering the vagina (Fig. 8) posteriorly, the uterus will be loosened. A finger may be introduced into the vagina (this may be done safely if vagina has been properly scrubbed, douched, and iodinized), which may act as a guide for the application of clamps to the vagina, thus insuring the cutting out of the uterus but eliminating the possibility of cutting too much of the broad ligament, of injuring the ureters or bladder, of cutting into the uterus, and of leaving part of the cervix *in situ*. In this the technique resembles that of the usual vaginal hysterectomy. Fourth, careful closure of the vaginal wound. This should be done in an anteroposterior direction and not from side to side for the latter might cause distortion or injury to the ureters. The technique of closure should include: (a) suture of the muscle walls of the vagina, (b) the attaching to them of the round ligaments (Fig. 9), uterosacral ligaments, ovarian ligaments if left, and the (Fig. 10) uteropubic fascial plane, (c) the covering of the wound completely and exactly with the vesical peritoneum.

CONCLUSION

1. The upper pelvic floor is made of the unstriped muscle, elastic and connective tissue derived from, or attached to, the lower part of the uterus and vagina. It includes the fibrous bands or sheaths of the nerves, blood vessels, lymphatics, and ureters lying in the broad ligaments, the levator ani and its fascial coverings which are attached to that of the compressor urethræ anteriorly, to the ischial spine and to the coccyx posteriorly and which blend with the aponeurosis of the muscles which lie above it in the broad ligament.

2. In total abdominal hysterectomy it is important to employ a technique by which one may remove the entire uterus without invasion of the broad ligament.

3. The tissues of the parametrium and paracolpos should be used to ensure a firm closure of the vaginal wound and to maintain the support of the upper pelvic floor.

BIBLIOGRAPHY

1. Alexandroff, S. A. Retroflexion operation. Zentralbl. f. Gynaek., 1903, 25: 762.
2. Arvard. Gaz. méd. de Par., 1854, 203, 218.
3. Baldwin, J. F. The technic of abdominal hysterectomy. Am. J. Obst., 1917, 75: 263.
4. Bardeleben, Karl von. Ueber die Lage der weiblichen Beckenorgane. Anat. Anz., 1888, 3: 535.
5. Bardeleben, Haeckel, and Frohse. Atlas der topographischen Anatomie des Menschen. 3d ed. Jena: G. Fischer, 1904, Fig. 149.
6. Bell, W. Blair. Principles of Gynecology. 3d ed. New York: Wm. Wood & Co., 1919.
7. Bidloo, Godefridi. Anatomia Humane Corporis. Amsterdam: J. Tomerin, 1685.
8. Blaisdell, Frank E. The anatomy of the sacro-uterine ligaments. Anat. Record, 1917, 12: 2.
9. Boivin and Dugés. Traité pratique des maladies de l'utérus et de les annexes. Paris: J. B. Baillière, 1833.
10. Bonney, Victor. Sustentacular apparatus of female genital canal. J. Obst. & Gynec., 1914, 25: 328.
11. Braune, Ch. Wilh. Topographisch-anatomischer Atlas. Leipzig: Veit, 1872.
12. Caldwell, William E., and Moloy, Howard C. The rôle of the lower uterine soft parts in labor. Am. J. Obst. & Gynec., 1936, 32: 727.
13. Caldwell, William E., Moloy, H. C. and D'Esopo, D. A. Further studies on pelvic architecture. Am. J. Obst. & Gynec., 1934, 28: 482–497.
14. Cameron, John. Fascia of the pelvis. J. Anat. & Physiol., 1907–1908, 42: 3.
15. Idem. Fascial perineum and pelvis. J. Anat. & Physiol., 1908.
16. Choulant, Johann Ludwig. History and Bibliography of Anatomic Illustration. Translated and edited by Mortimer Frank. Chicago: University of Chicago Press, 1920.
17. Cohn, Ernst. Ueber die primaeren und definitivem Resultate der Prolapsoperation. Ztschr. f. Geburtsh. u. Gynaek., 1887–88, 14: 501
18. Cruveilhier, J. Cathétérisme utérin suivi de mort. Gaz. méd. de Par., 1854, (Feb. 7).
19. Idem. Traité d' anatomie. Paris, 1874.
20. Cunningham, Arthur. Text Book of Anatomy. 5th ed. New York: Wm. Wood & Co., 1929.
21. Curling, T. B. Observations on the structure of the gubernaculum. Lancet, 1840, 2: 70–74.
22. Davies, Joshua W. The preperitoneal layer. Surg., Gynec. & Obst., 1935, 60: 941.
23. Deaver, John Blair. Surgical Anatomy—Pelvic Cavity. Vol. 3. Philadelphia: P. Blakiston, 1903.
24. Debierre and Pravaz. Contribution à l' étude du gubernaculum testes. Lyon méd., 1886, 52: 101, 133, 167.
25. Delbet. Des suppurations pelviennes chez la femme. Poirier et Charpey, Tome 5. Paris, 1891.
26. Denonvilliers. Thèses de Paris, 1837, No. 285, III.
27. Dickinson, Robert L. Genital prolapse. Am. J. Obst., 1910.
28. Donald, Archibald. The operative treatment of prolapse of the uterus and vagina. J. Obst. & Gynæc., 1902, 1: 312.
29. Idem. Operation in cases of complete prolapse. J. Obst. & Gynæc., 1908, 13: 195.
30. Idem. A short history of the operation for colporrhaphy with remarks on the technique. J. Obst. & Gynæc., 1921, 28: 256.
31. Dudley, E. C. Gynecology. Philadelphia: Lea & Febiger, 1908.
32. Duncan, J. Matthews. On the displacements of the uterus. Edinburgh M. & S. J., 1854, 81: 321.
33. Emmet, Thomas Addis. Principles and Practice of Gynecology. 2d. ed. New York: Lea, 1880.

34. FABRICIUS, HILDANUS. Opera Observationum Curationum. Pavia: A. Meggliatti, 1625, 1647, p. 893.
35. FARABOEUF, L. H. Les vaisseaux sanguins des organes génito-urinaires du périnée et du pelvis. Paris, 1905.
36. FARABOEUF and VARNIER. L'étude chirurgie et de la pratique des accouchements. Anatomie. Paris: G. Steinheil, 1891.
37. FOTHERGILL, W. E. An operation for prolapse complicated by hypertrophy of the cervix. J. Obst. & Gynæc., 1913, 24: 19.
38. Idem. The supports of the pelvic viscera. Proc. Roy. Soc. Med. (Obst. & Gynec. Section), 1907–1908, 12: 43, 58, 214.
39. Idem. The end results of the vaginal operations for genital prolapse. J. Obst. & Gynæc., 1921, 28: 251.
40. Idem. The development of vaginal operations for genital prolapse. Brit. M. J., 1926, 1: 273.
41. FRAENKEL. Principles of the treatment of genital prolapse. Am. J. Obst. & Gynec., 1927, 13: 757.
42. FRANK, ROBERT T. Anatomy, pathology and treatment of uterine prolapse, rectocele and cystocele. Surg., Gynec. & Obst., 1917, 25: 225.
43. Idem. Gynecological and Obstetrical Pathology. New York: Wm. Wood & Co., 1931.
44. Idem. Am. J. Obst. & Gynec., 1932, 24: 574, 778.
45. FRANKENHAUSER, F. Die Nerven der Gebaermutter und ihre Endigung in den Glatten Muskelfasern. Jena, 1867—plate VI.
46. FREDET, PIERRE. Recherches sur les artères de l'utérus. Thèse de doct., Paris, 1898–1899.
47. FREUND, M. B. Klin. Beitr. 3. Gynaek., Breslau, 1862-1865.
48. FREUND, W. A. Ueber das Beckenbindegewebe Atlas. Gynaek. Klin., Strassbourg, 1885, 1st vol., p. 203.
49. Idem. Das Bindegewebe in weiblichen Beckens. Muenchen. med. Wchnschr., 1901.
50. GLANTENAY and GOSSET. Appareil urinaire. Poirier et Charpy. Traité d'anatomie humaine. Vol. 5, Part 1., Paris, 1901.
51. GOODALL, J. R. Total versus subtotal hysterectomy. Tr. Am. Gynec. Soc., 1936, p. 61.
52. GRAY, HENRY. Anatomy, Descriptive and Surgical. 26th ed. London: Longmans Green & Co., 1935.
53. GUYON. Études sur les cavites de l'utérus. J. de physiol., 1858, vol. 2.
54. HALBAN, JOSEF. Operative Behandlung der weiblichen genital Prolapsen. Wien and Leipzig, 1919.
55. HALBAN and SEITZ. Anatomie und Pathologie des Weibes. 1927, 4: 478. Berlin: Urban &. Schwarzenberg.
56. HALBAN and TANDLER. Anatomie und Aetiologie der Genital-Prolapse beim Weibe, 1907.
57. HART, DAVID BERRY. The Structural Anatomy of the Female Pelvic Floor. Edinburgh, 1880.
58. Idem. Atlas of Female Pelvic Anatomy. Edinburgh, 1884, plate XXV.
59. Idem. Physiological descent of the ovaries in the human fetus. J. Anat. & Physiol., 1909–1910, 44: 27.
60. HENLE, J. Handbuch der System. Anat. des Menschen. Eingeweidelehre 2d ed., vol. 2. Braunschweig, 1873.
61. Idem. Anatomie des menschen Atlas. Braunschweig, 1901.
62. Idem. Grundisch Anatomie des Mensch und Atlas. Braunschweig, 1901.
63. HOLL, M. Die Muskeln und Fascien des Beckenausganges. Handbuch der Anatomie des Menschen —von Bardeleben. pt. 2, 2d ed. 1897, 244.
64. HOUSTON, JOHN. Descriptive Catalogue of the Preparations in the Museum of the Royal College of Surgeons in Ireland. Vol. 2. Dublin, 1840.
65. HUGHES, JONES, W. E. A. Suspensory ligament of pelvic viscera. Australian & New Zealand J. Surg., 1936, 5: 227–232.
66. HUNTER, JOHN. Observations on Certain Parts of the Animal Economy. London, 1786.
67. HUNTER, WILLIAM. Anatomy of the Human Gravid Uterus. London, 1774.
68. HUNTINGTON, G. S. Anatomy of Human Peritoneum. Philadelphia: Lea Bros., 1903.
69. HUSCHKE. Lehre von dem Eingeweiden. Encyclopedie Anatomique. Paris: Baillière, 1843.
70. IWANOFF, NICHOLAUS. Die Muskulature der Mutterbaender. Arch. f. Anat., Leipzig, 1911.
71. JELLETT, HENRY. Cause and treatment of procidentia uteri. J. Obst. & Gynæc., 1912, 21: 335.
72. KEIBEL and MALL. Handbuch der Entwicklungs geschechte des Menschen. Vol. 2, p. 918. Leipzig: S. Hirzel, 1911.
73. KENNEDY, WILLIAM T. Reconstruction of cervical ligaments following complete hysterectomy. Am. J. Obst. & Gynec., 1930, 20: 51–56.
74. KOCKS. Die normale u. path. Lage und Gestalt des Uterus sowie deren Mechanick. Bonn, 1880.
75. KOHLRAUSCH, O. Die weiblichen Beckenorgane. Leipzig: S. Hirzel, 1852.
76. Idem. Zur Anatomie und Physiologie der Beckenorgane. Leipzig: S. Hirzel, 1854.
77. KOSTANECKI, K. Development of lateral segment of broad ligament; relation to Clado's appendiculo-ovarian ligament. Arch. d'anat., d'histol. et d'embryol., 1930, 12: 75–108.
78. KOSTER, H. Supports of uterus. Am. J. Obst. & Gynec., 1933, 25: 67–74.
79. Idem. Support of pelvic viscera and mechanism of prolapse. Am. J. Surg., 1935, 29: 226–235.
80. LUSCHKA, HUBERT. Die Anatomie des menschlichen Bauches. Pp. 323, 364. Tuebingen, 1863.
81. Idem. Die Anatomie des Mensch. Beckens. Tuebingen, 1887.
82. LA TORRE, FELICE. L'utero attraverso i secoli, 1617.
83. LACEY, F. H. Results of vaginal operation for prolapse by the Manchester school. J. Obst. & Gynec., 1921, 28: 260.
84. LEGUEU. Bull. Soc. anat. de Par., 1897.
85. MACKENRODT. Ueber die Ursachen der normalen und pathologischen Lagen des Uterus. Arch. f. Gynaek., 1894, 48: 393 and plate XII, Fig. 6.
86. MARTIN, A. Volkmanns Samml. klin. Vortr., 1880–1886, No. 183.
87. MARTIN, E. Hand Atlas der Gynaekologie und Geburtshilfe. Berlin: A. Hirschwald, 1878.
88. Idem. Der Haft apparat der weiblichen Genitalien. Berlin: S. Karger, 1911.
89. MAURICEAU, FRANCOIS. Traité des maladies des femmes grosses. Paris, 1740, 6.
90. Idem. Traité des femmes grosses, etc. 3d ed., Paris, 1681.
91. Idem. Traité des maladies des femmes enceintes. Paris, 1668, p. 373.
92. Idem. Observation sur la grossesse et l'accouchement. Paris, 1715.
93. MORITZ, MANFRED. On the nature of the so called ligament of Mackenrodt. J. Obst. & Gynæc., 1913, 23: 135.
94. NYULASEY. The supports of the uterus. Surg., Gynec. & Obst., 1921, 33: 53.
95. PANSCH. Arch. f. Anat. u. Physiol. Reichert u. du Bois. Leipzig, 1874—S. 702.
96. Idem. Grundriss der Anatomie des Menschen. Leipzig, 1881.

97. PARAMORE, R. H. The supports—chief of the female pelvic viscera. Proc. Roy. Soc. Med. (Obst. & Gynec. Sect.), 1907–1908, 195.
98. PATERSON, A. M. The mechanical support of the pelvic viscera. J. Anat. & Physiol., 1907, 41.
99. PIROGOFF, NICOL. Chirurgische Anatomie. Leipzig: C. F. Winter, 1859-1860.
100. POIRIER and CHARPY. Traité d' anatomie humaine. Vols. 1, 2, 3. Paris, 1896.
101. POLK, W. M. Suprapubic operation upon the pelvic floor. Tr. Am. Gynec. Soc., 1909, 34.
102. Idem. The surgery of the upper pelvic floor by direct approach. Tr. Am. Gynec. Soc., 1910, 35.
103. REYNOLDS, EDWARD. Discussion. Tr. Am. Gynec. Soc., 1910, 35: 173.
104. RICHARDSON, EDWARD H. Total hysterectomy by the abdominal versus the vaginal routine in benign uterine disease. Tr. Am. Gynec. Soc., 1936.
105. RIEFFEL, H. L'appareil génital de la femme. Poirier et Charpy. Traité d'anatomie humaine. Paris, 1901, 1st ed., vol. 5, part 1, p. 427.
106. VON ROSTHORN, A. Die Krankheiten des Beckenbindegewebes. Veit's Handbuch der Gynaekologie. Wiesbaden, 1898. vol. iii, 2d half.
107. ROKITANSKY. Allg. Wien. med. Ztg., 1895.
108. Idem. Lehrbuch der path. Anatomie. 3d ed. Vienna, 1861.
109. ROUGET, CHARLES. J. de physiol., 1858, vol. 1.
110. SAPPEY, PH. C. Traité d'anatomie. 3d ed., Paris, 1852.
111. Idem. Vaisseaux lymphatiques. Paris, 1885.
112. SAVAGE, HENRY. Illustrations of the Surgery of the Female Pelvic Organs. 1863, 1876, 1880.
113. Idem. Surgical Anatomy of the Female Pelvic Organs. 5th ed. London, 1882.
114. SCHAUTA, FRIEDRICH. Lehrbuch der gesammten Gynaekologie. Pt. 2, Frauen Krankheiten. Leipzig, 1907.
115. SCHROEDER, ROBERT. Lehrbuch der Gynaekologie. 2d ed. Leipzig, 1926.
116. SELLHEIM, HUGO. Atlas normalen und pathologischen Anatomie des weiblichen Beckens. Leipzig, 1900.
117. Idem. Ligamentum Teres Uteri. Beitr. 3—Geburtsh. u. Gynaek., vol. 4, No. 2. p. 165.
118. SHAW, W. FLETCHER. Treatment of prolapsus uteri. Tr. Am. Gynec. Soc., 1933, 58: 70.
119. Idem. The treatment of prolapsus uteri. Proc. Roy. Soc. Med. (Obst. & Gynec.), 1929–1930, p. 1159.
120. SIMS, MARION. Clinical Notes on Uterine Surgery. New York: Wm. Wood & Co., 1871.
121. SMELLIE, WILLIAM. Set of Anatomical Tables and Practice of Midwifery. 2d ed., London, 1761.
122. SOBOTTA, JOHANNES. Atlas and Textbook of Human Anatomy. Philadelphia: W. B. Saunders Co., 1906.
123. SPALTEHOLZ. Hand Atlas of Human Anatomy. Leipzig, 1900.
124. STRONG, R. A. Anatomy of the visceral pelvic fasica J. Anat. & Physiol., 1907, vol. 41.
125. SUE, PIETRO GIUSEPPE. Quoted by Felice La Torre.
126. SYMINGTON, JOHNSON. Normal anatomy of the female pelvic floor. Edinburgh M. J., 1889, 34 788.
127. TANDLER, JULIUS. Lehrbuch der systemmatischen Anatomie. Vol. 2, pp. 296–312. Leipzig, 1923.
128. Idem. Veit's Handbuch der Gynaekologie. Edited by Stoeckel. 1930, p. 207.
129. TANDLER and HALBAN. Topographie des weiblichen Ureters. Vienna: Braunmueller, 1901.
130. TESTUT, LEON. Vaisseux et nerfs anatomie et physiologie. Paris, 1880.
131. Idem. Traité d'anatomie humaine, appareil urogenital. P. 815. Paris, 1901.
132. TESTUT and JACOB. Traité d'anatomie topographique. 3d ed., 2—Paris, 1914.
133. THOMPSON, P. The pelvic diaphragm. J. Anat. & Physiol., 1901, 35.
134. Idem. Studies from the Anatomy Department of Owens College. 1900, vol. 2.
135. TWEEDY, E. HASTINGS. Cause and treatment of procidentia uteri. J. Obst. & Gynæc., 1912, 21: 136.
136. VESALIUS, ANDREA. Icones Anatomicae. De Humane Corporis fabrica, 1543.
137. DA VINCI, LEONARDO. "Schemata of the Female Pelvic Viscera in Situ" about 1400. Catalogue of the Drawings at Windsor Castle. Vols. 1 & 2, p. 5, No. 12281.
138. VIRCHOW. Verhandl. d. Gesellsch. f. Geburtsh. Berlin, 1851.
139. Idem. Ges. Abdhand. der Wissenschaft. Med., 1856, S-189.
140. Idem. Ueber die Gefaesse der schwaengeren Gebaermutter. Verhandl. d. Gesellsch. f. Geburtsh., Berlin, vol. 8, 1855.
141. WALDEYER. Beitrage zur Kenntnis der Lage der weiblichen Beckenorgane. Bonn, 1892.
142. Idem. Anat. Anz., 1892, p. 42.
143. Idem. J. Anat. & Physiol., 1897, 32: 1.
144. Idem. Das Becken. Bonn: Cohen, 1899.
145. WARD, GEORGE GRAY. Kelly's Gynecology. New York: D. Appleton & Co., 1928.
146. ZIEGENSPECK, ROBERT. Zur Aetiologie der Prolapsus Uteri. Wurz. Kongress. 1886.
147. Idem. Ueber die normale und pathologische Anheftungen der Gebaermutter. Arch. f. Gynaek., 1887, vol. 31.
148. ZUCKERKANDL. Ueber die Fascia perinei propria. Wien. med. Jahrb., 1883.

BIOLOGICAL SURGERY IN TUBERCULOUS PATIENTS

Prof. CARLOS ROBERTSON LAVALLE, F.A.C.S., Buenos Aires, Argentina

IT is a well known fact that every trauma to, or infection in, living tissue produces a reaction the severity of which depends upon whether the body is vulnerable or has been prepared by successive attacks to repel the inciting agent. For example, a primary attack of tuberculosis frequently produces in the human body an inflammatory reaction later to produce caseous lesions of varying intensity, known as the primary lesion of Ghon. The local reaction affects all the tissues and circulating fluids of the body, a fact well demonstrated by the von Pirquet test; here a positive reaction is obtained in the arm although the primary tuberculous focus may be located in the lungs.

If, however, the local caseous lesions resulting from the first attack remain quiescent and there is no other reaction on the part of the body, the patient may suffer a second attack by the Koch bacillus, resulting in tuberculosis of the bone, the lungs, the skin, or other part of the body. In the second attack, the Koch bacillus finds the tissues of the body altered—they have developed an allergy, the result of the first inoculation. The manner in which the reaction of the tissues is affected by the presence or absence of allergy is demonstrated in the production of the Koch phenomenon. In our experiment in producing the Koch phenomenon we used two guinea pigs. One of these had been successfully inoculated with a small injection of attenuated Koch bacilli a few months previously; consequently, it had a primary tuberculous lesion, in other words, a primary lesion of Ghon. The other guinea pig had received no preliminary injection of Koch bacillus and had no tuberculous focus. Both pigs were given subcutaneous injections of equal amounts of virulent Koch bacilli. The reaction in the two pigs was very different. In the first guinea pig, which had been previously inoculated with tuberculosis, in the first few days, a black crust formed and fell off leaving an ulcerated area which was quickly filled in with cicatricial tissue. Thus the site at which the second injection had been made healed. In the second guinea pig which had received no previous injection of the Koch bacillus, the skin ulcerated within a month and the affected area became an extensive tuberculous ulcer, finally resulting in the death of the animal.

From these experiments it would seem that in the first animal, by virtue of having received a previous inoculation of the tubercle bacillus, the reaction of the plasma and circulating fluids had been modified; an allergic state developed which might be interpreted as an aggressive offensive against the new invaders. In other words, there was produced an immunization which was instrumental in curing the local lesion.

The experiment demonstrated clearly the phenomenon of Koch, namely: (1) that the primary inoculation is virgin soil free from tuberculosis, and (2) the re-inoculation in soil previously infected, caused dissimilar results: the first resulting in a caseous ulcer and the second in a cicatrix in tuberculous tissue without caseation. It is essential that the same tissue be used in both cases. The subcutaneous tissue, as in the experiment on the guinea pigs, is the most accessible and the most easily observed.

Almost every one from earliest childhood has a primary tuberculous lesion which is well tolerated. The lesion is usually in the form of a cicatrix with caseous material and with calcium salts frequently present, is about the size of a grain of wheat, and is sealed in the regional lymphatic ganglions. This sealed focus forms what is called the primary lesion of Ghon, which consists of live Koch bacilli of low virulence, and provides, during the life of the individual, substances which produce active immunization processes, like those which brought about the reaction in the guinea pig experiment.

From the Department of Pathological Surgery, Faculty of Medicine, Buenos Aires.

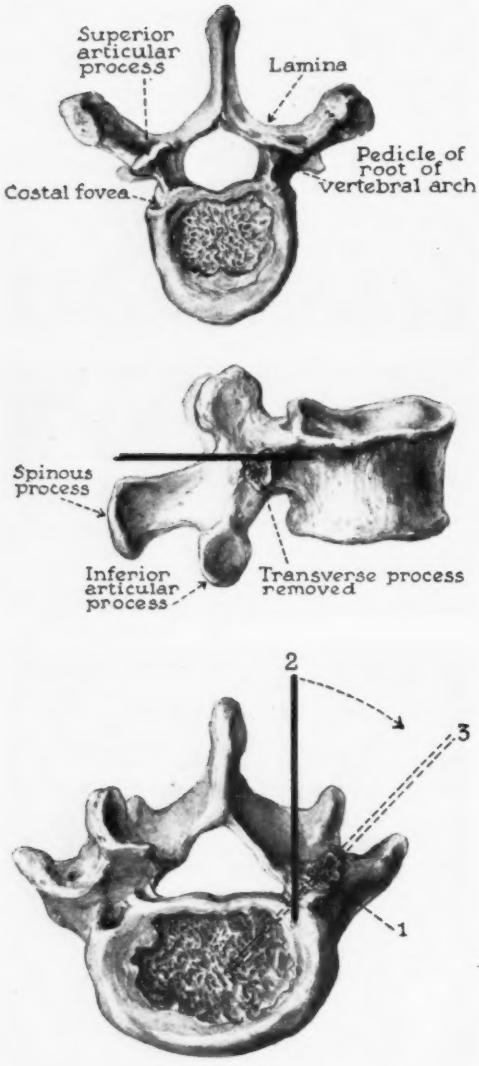


Fig. 1. Diagrams showing the operative procedure. In the drawing at top, it is noted that the space between the spinal process and the transverse process on one side is thoroughly exposed. Hemostasis is obtained by pressure. The transverse process is then removed by bone rongeurs. With the neck of the rib as a guide, the operator inserts the perforator through the exposed base of the transverse process with the pedicle, vertically, through the exact center to the depth of 1 inch—a distance equal to the anteroposterior secant of the spinal foramen at this level. Care is used to avoid penetrating the spinal canal; for that reason the body of the pedicle is used. With the point of the perforator in the body of the vertebra, the operator further inserts the perforator, at an angle of 45 degrees and to the depth of 1 inch, which is generally sufficient we fill the tunnel with an autobone graft as a hemostatic measure. The caseous portions and the intervertebral disc are avoided. The middle drawing is a lateral view of the dorsal vertebra. In the bottom drawing, of lumbar vertebra we note: *1*, the superior articular process has been removed by bone rongeurs; *2*, the perforator is inserted for the first time and is shown reaching the interior of the pedicle; *3*, the perforator has been inserted a second time and now reaches the middle of the body of the vertebra.

Endogenous re-infection in man probably arises from the reactivation of a Koch bacillus deposit which has remained dormant since the initial attack. This reactivation may take place in the selfsame primary lesion of Ghon or it may occur in any other site. The later re-infection causes mild infections in the blood stream which are rapidly destroyed in the blood. At times, however, tissue in a state of lowered resistance may be involved or the re-infection may be so overpowering that the natural defenses of the body provided by the lesion of Ghon will be overcome. In such instances the tubercle bacilli will colonize and thrive.

For 25 years we have sought diligently to find in the various tuberculous lesions in man these tuberculous re-infection nuclei which stimulate the different tissues of the body to react so unexpectedly after having attained an allergic state. Such scars or nuclei we have chosen to call successively strangulated focus, chancre, and now nucleus of post allergic focal infection.

We have found these nuclei in bone tissue and in the lungs. It is in aiding in the dispersion of the substances which are developed in these foci that we base our theory of treatment. At first we used the method only in cases of bone tuberculosis; today, however, we use the method in every case of tuberculosis whether it is of the lungs, the larynx, or other organs, the only exception being tuberculosis of the meninges.

Our first studies were made with animals: first, with tuberculous cows, then with dogs, rabbits, and finally with guinea pigs. We used attenuated cultures of the Koch bacillus for inoculation material. Our experiments were carried on in large, well equipped laboratories of the Instituto Modelo de Clin-

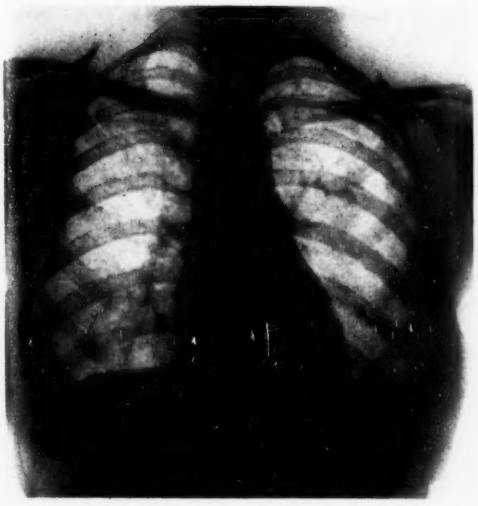


Fig. 2. C. S., before operation. A cavity the size of a penny and containing fluid is shown in the right apex. There is minute, nodular infiltration in the periphery and the paratracheal ganglia on the right side are very marked.

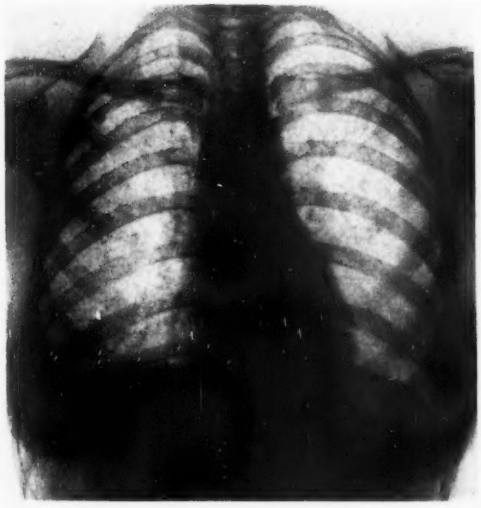


Fig. 3. C. S., 14 months after operation. The nucleus of post allergic focal infection had been perforated but once with a trocar. The cavity has been replaced by cicatricial tissue; the hilar and paratracheal ganglia are diminished in size; fibrotic tendency is very marked. Patient does not cough, no Koch bacilli were found in the sputum and general condition is excellent.

ica Medica of Buenos Aires, under the direction of Professor Luis Agote, who was the first in the world to use only citrated blood in blood transfusions in the human. After many months of study, however, all this material had to be abandoned, since we could not follow the development of the tuberculous processes for a sufficient length of time as in the human being and also the animals for experimentation were not of manageable size.

We then began to devote our entire work to the minute observation of the pathological physiology in tuberculous lesions in knees which were obtained by transverse section of the human femur and tibia, our object being to note, centimeter by centimeter, any change in consistency, color, or quality of the blood at the different levels of resected bone. We studied especially the smaller and healthier portions rather than the portions with fatty degeneration, red or gray, with caseous necrosis, cavities.

After persistent search our presumption was verified: within a section of the bone, there oozed forth under pressure a small quantity of black, thick, tar-like blood from a well defined undermined spot, about a half centimeter in diameter. In addition we noted, adherent to the clot, an area of grayish tissue, resembling cicatricial tissue. Further studies revealed that this clot contained many attenuated tubercle bacilli which had become granular. The section showed an intense, specific reaction of the reticulo-endothelial system, as in caryocinesis. In the midst of a large quantity of collagenous substance, epitheliod cells formed Koester follicles but without caseous necrosis, that is, there developed a tuberculous tissue structure with great tendency to form one scar.[1]

In roentgenograms of patients with tuberculous osteo-arthritis who have been treated with rest and heliotherapy only, we were able to prove that the appearance and size of the nucleus of post allergic focal infection did not change from year to year, but that the destructive process continued to progress throughout the extent of the bones forming the diseased joints. We have devoted much

[1]See Tuberculosis quirurgica. Semana méd., 1935, No. 30.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 4. L. M., 20 years old, before operation. Patient has had Pott's disease for 1 year. There was a large palpable iliac abscess and pulmonary tuberculosis. The first and second lumbar vertebræ were atrophied, with blurred trabecular structure. The intervertebral disc is absent. Cheesy necrosis and wasting were noted in the lower half of the third lumbar vertebræ in the upper middle part of which the nucleus is visible.

Fig. 5. L. M., 15 days after operation, which was performed in the presence of Dr. Albee of New York. The arrow marks the presence of a tunnel in the body of the third lumbar vertebra. This tunnel was made by the perforator which was inserted exactly to penetrate the nucleus of post allergic focal infection the tunnel was bunged with a little autobone graft as a hemostatic measure. There has been partial reabsorption of the caseous portions and the bony structures of the vertebra are well defined. Recalcification of the spinal column is noted as well as the presence of cortex and trabeculæ.

Fig. 6. L. M., 8 months after operation. There is marked recalcification of the cortex and trabeculæ. Cicatrization of the third lumbar vertebra is plainly visible and there is a tendency to fibrosis. The retraction of the scar, pushes the third lumbar on the fourth, due to the absence of the intervertebral disc. We do not apply casts and do not immobilize patients except when the cicatricial retraction is so great that marked kyphosis may result. The pulmonary tuberculosis is healed.

time to the study and observation of this focal point in roentgenograms. Interpretation has been made easier recently by the rapid advance and improvement in roentgen-ray technique. This special focal point, this nucleus of post allergic focal infection, appears to us as a star-shaped scar or agglomeration of tiny spots, the size of pin heads or small grains of rice. Here and there, however, the spots are always sharply outlined and resemble small metallic foreign bodies with rough edges and arranged often in the form of the spokes of a wheel. They usually are arranged in the form of an arc with three or four of the radii of the circle at equal intervals but the circle is not completed in the film.

If the peripheral or outside zones of the area supposed to contain or containing this nucleus of post allergic focal infection are lightened with a solution of red aniline dye, the common procedure in "overcontrast" photographs, it is possible to obtain in prints of films a true picture of the nucleus with the characteristics noted.

We have sent to several hundred professors and to a total of 148 libraries of medical colleges of different states and countries films by which the characteristics of the nucleus of post allergic focal infection could be recognized.

In his book regarding local immunization[1], Besredka, accepts Bichat's theory that there exist in each organ clusters of cells, having the special ability to react not only anatomically but as well in their physiological functions. Thus Besredka and others have stated

[1]See Besredka. Immunization locale. Paris: Masson et Cie, 1925, p. 244.

Fig. 7, left. G. L., Pott's disease. (This was Case 75 of "My first 100 cases of Pott's disease reported in La Semana Medica, No. 26, 1931.) The caseous necrosis and the destruction of 4 vertebræ, before operation. The intervertebral discs are absent. Patient was operated upon by perforating the first lumbar vertebral body. Patient was discharged a month later, walking without cast or support of any kind.

Fig. 8. G. L., 10 years after operation. The vertebræ formerly riddled with caseous necrosis, have now become transformed into a solid bone, rigid block. Patient is in very good condition, has no pains or contractions, and is fit for military service.

that certain cellular groups are susceptible to infection but become immunized even though the whole body responds, that is to say a tissue immunization exists. Confirming this theory of the elective tendency of certain cells against certain forms of infection of various virulence, we emphasize that we find that only one nucleus of post allergic focal infection exists in each case of osteo-arthritis, notwithstanding the fact that it may be formed by the combination of several diseased continuous bones. In coxalgia, for example, the nucleus, very large, is very often located below and to the inside of the antero-inferior iliac spine. In Pott's disease, the nucleus is very large and is located in the vertebral body near the point of implantation of both articular pedicle, often in the decalcified vertebra above or below the caseous necrotic focus. In doubtful case, it must have perforated two vertebræ. In knee it is small and very difficult to see.

We have presented here a process in which the body overcomes the local infection and exhibits a remarkable tendency, by virtue of large amounts of collagenous substance, to weaken the organisms which have established themselves and, by symbiosis, have begun to multiply. These bacilli do not reach the stage whereby they change the condition of tissue in which they are located because the body lessens their virulence. Furthermore, as has been accepted by many, there is formed in all "focal infections," a biological block that does not permit to pass the haptins, globulins (Landsteiner) or antibodies that in this instance are about to form autovaccines but allows to go through only the lysins (Maurice Nicolle), the poisons, which are more fluid, amino-acids. We maintain, then, that if there is an advantage locally, the system may suffer unless it is possible to free these imprisoned elements, elements capable

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 9. F. V., before operation. Coxalgia. (This is Case 95 of the statistics presented at the Congress of Rosario, 1934.) The roentgenogram discloses an enormous abscess, clearly visible by opaque substances. Local heat, pain, edematous infiltration, and adenitis were noted. The bone was so atrophied that it was almost transparent. The neck and head of the femur and articulating surface of the iliac bone and the cortex of the femur were considerably thinned.

Fig. 10. F. V., 1 month after operation. A bone graft had been inserted making a tunnel in the neck and head of the femur and another one in the inside of the antero-inferior iliac spine. The abscess was completely opened in the operation but closed later by primary intention. The pain has diminished and there is a decided improvement in the local and general condition. The iliac and femoral bones have become recalcified and are now more distinct. Patient discharged 4 months after operation, walking without cases or supports.

Fig. 11. F. V., 6 years later. Patient maintains his good general health. He has led an active life since discharge. Ankylosis is shown in the roentgenogram as well as marked recalcification and thickening of the cortex. There are visible beautifully marked lines of resistance in the femur.

of forming autovaccines. Our experiences confirm the view of those, among whom is professor Julio Mendes of Argentina, who believe that tuberculosis is principally a "focal infection." From such a focus lysins sally forth and, by greatly diminishing the defenses of the body, facilitate the caseous transformation of the new Koch bacilli localizations. For this reason I strive with my procedure to liberate the haptins, for, when a nucleus of post allergic focal infection is perforated, it results in helping to reestablish the health of the patient: rapid detoxication and a tendency toward cicatrization of the existing lesions preceded by reabsorption of caseous material are noted and become more pronounced in the months following this comparatively simple operation. The explanation of these phenomena is easy. The status of the nucleus of post allergic focal infection is changed completely by its perforation: immediately the blood rushes in; the microbes suffer by the rude change in their culture medium; oxygen is rapidly brought in and since oxygen does not favor the growth of tubercle bacilli they become weakened. The weakened bacilli, besides being easily affected by the lipolytic and proteolytic ferments, oxidases, etc., produce above all, weak antigens, namely autovaccines.

Since the patient carries these foci within himself—production centers of autovaccines—this action becomes continuous and prolonged, eventually diminishing the thickness of the new caseous masses. Meanwhile nourished by the newly formed blood vessels this material is transformed into whole lumps and, finally, into sclerosed, fibrous cicatricial masses.

Serological study shows that the Besredka and Vernes reactions are accentuated after the operation but frequently become negative in the following months, when, clinically and roentgenographically, the patient is cured. In the days following puncture of the focus, the cutaneous reaction with von Pirquet's tuberculin becomes so marked that it generally takes the papular form, and sometimes

is hemorrhagic with extensive lymphangitis.

A bacteriological and histological study of a tuberculous knee, operated upon by us 10 years previously, was made by Dr. Vivoli, chief of the laboratory of the Hospital de Enfermedades Infecciosas, and Dr. Llambias, professor of pathological anatomy of the Faculty of Medicine of Buenos Aires. They both demonstrated the total absence of both the Koch bacillus and caseous material in the areas formerly carious but now refilled with compact, sclerosed cicatrices. In other words there was total elimination of the Koch bacillus; therefore the tuberculous infection had been cured.

It is generally admitted today that every tuberculous lesion, regardless of where it is located in the body, originated in the lung, or that tuberculosis was at one time manifest there.

The nucleus which is found in the lung, the nucleus of post allergic focal infection, is similar in every respect to that which we see in bone tuberculosis. In the lungs the nucleus is visible in well taken stereoscopic roentgenograms but only one is found for the two lungs, an observation which leads me to believe that it is a nucleus of post allergic focal infection. Quickly upon perforation of the nucleus detoxication begins and just as quickly or even more rapidly there follows in the succeeding months a transformation of the tuberculous caseation process into a fibrous and finally a cicatricial sclerosis. At the same time modifications of equal intensity occur in other tuberculous lesions of the body wherever located—in the joints, larynx, or even the intestines—regardless of how far away the perforated nucleus may be.

The operative technique is very simple: once the nucleus of post allergic focal infection is visualized in stereoscopic roentgenograms, precise information is at hand as to the depth of the focus and we can then perforate the focus by the simple implantation of a bone autograft into the focus. The nucleus, which is always subcortical, may also be perforated by means of a trocar which may carry in the eye of its plunger various strands of catgut of different absorption dates, which may be left to fill the tunnel made by the needle in the lung parenchyma. Catgut is not indispensable; the puncture tunnel in the lung is innocuous out of the hilum[1] and cheesy necrotic focus. These steps are sufficient to start the process of cure, in a few or many months, according to the extension and severity of the infection and the soil in which these lesions develop.

The reading of x-ray films to locate the nucleus of post allergic focal infection to operate upon is, and always will be, the essential and most vital point in this method of treating tuberculosis. Infinite care must be used and many stereoscopic roentgenograms must be made daily. Considerable practice in interpreting the roentgenograms is necessary to recognize in a shadow the outline of the scar and to determine its depth and location for guides in the perforation.

At first we were not as successful as we are at present. Our present figure is 76 per cent successful and we hope to better that even though we will use the method in grave cases. We used the method in Pott's disease 11 years[2] ago and we also have patients cured after the implantation of grafts in the lung 9 years ago. We can say, therefore, that our procedure has stood the test of time.

At our request the Faculty of Medicine of Buenos Aires appointed 8 professors, with the dean as president, as a committee to supervise operations and to study the results obtained, and after 6 months of work they made the following report:

Professor Robertson Lavalle's treatment of tuberculosis is simple and innocuous. In the patients whose progress we have followed after the operation, we have observed truly surprising results. We have examined patients operated upon previous to our appointment and their condition has remained satisfactory after application of this treatment.

(Signed) Professors José Arce (Dean), José A. Saralegui, Carlos Fonso Gandolfo, Raúl Arganaraz, Antonio R. Zambrini, Ludovico Facio, Enrique Castano, Ricardo E. Donovan.

After this report the University has in view creating a special institute where our method may be given a wider application.

[1]Bull. et mém. Soc. nat. d. chir., 1917, 43: 103.
[2]Semana méd., 1931. No. 26.

THROMBOPHLEBITIS OF THE APPENDICIAL VEIN COMPLICATING ACUTE APPENDICITIS

STUART Z. HAWKES, M.D., M.Sc.D., Newark, New Jersey

APPENDICITIS is a disease of civilized peoples. Wherever it occurs, the mortality is high. Statistics for the United States show that the number of deaths from appendicitis is more than one-half of that due to automobile accidents (21). In spite of many years' experience, it seems that there still are factors in treatment that can be bettered. One of the factors which contributes to the high rate of mortality is failure, in a certain group of cases, to recognize the presence of thrombophlebitis of the appendicial vein. The occurrence of this complication so alters the diagnostic, pathological, prognostic, and therapeutic features, that there may be justification for placing appendicitis, thus complicated, in a category of its own.

In this paper a survey of this type of appendicitis will be attempted, together with the operative treatment thus far practiced. A composite picture of the clinical history of suspected thrombophlebitis of the appendicial vein will be given and an operative procedure will be suggested by means of which the process may be localized. Finally, a series of illustrative cases which have occurred in the last 10 years will be cited. These cases were drawn from several Newark (N. J.) hospitals and will serve to show the complete picture in specific instances.

PATHOLOGICAL CONCEPTION OF THROMBOPHLEBITIS COMPLICATING APPENDICITIS

The formation of a clot in a vein is most frequently a protective reaction against the spread of an infectious agent which reaches its radicles. The infected clot is formed in the lumen of the vein in an attempt to prevent immediate regional spread of infection or the later development of infection of the blood stream. If the virulence of the micro-organisms is such as to cause progressive enlargement of the thrombus in the general direction of the heart, the result is the formation of an infected clot in a larger vein. Small pieces of such a clot may become detached and, in this way, an infected embolus is set free in the venous blood; the point where the embolus lodges depends upon where it was formed. Thus, in infections involving the intestines the liver receives the embolus by way of the portal vein, while an infected embolus arising in the head or extremities is filtered out by the lungs. When such an embolus comes to rest it causes a local tissue reaction which, in turn, is manifested, clinically, by a sudden rise of temperature and a chill.

The micro-organisms against which the body has the poorest protective mechanism are certain types of streptococci. They seem easily to penetrate local protective barriers and quickly gain entrance into the venous radicles. A chill may occur as a complication of any infective disease process, but more especially those caused by streptococci. For example, in acute mastoiditis a chill and rise in temperature indicate that the infection has spread to the lateral sinus, resulting in a thrombus. In order to forestall later emboli, surgeons ligate the jugular vein on the corresponding side.

A similar process is found in certain cases of acute appendicitis in which micro-organisms reach the venous blood stream and thrombophlebitis of the appendicial vein results. Such a condition is usually due to a rapid gangrenous process caused by infections in which the streptococcus predominates. The micro-organism probably causes gangrene by an overwhelming infection and by affecting the veins of the appendix. Once the venules are involved, a protective barrier against further spread is established by the formation of an infected thrombus which stops the venous drainage of the part and hastens gangrene (17).

Submitted in partial fulfillment of the requirements for the degree of doctor of medical science at New York University.

Whatever the mechanism may be which produces the thrombus, it does form in certain acutely inflamed appendices where there is rapid death of the part and in which the infection quickly reaches the venous radicles provoking the formation of a protective thrombus. Should a small portion of this clot break off, it is apt to lodge in the liver. In these circumstances a chill sets in, and a liver abscess eventually follows. No doubt there are many cases of acute appendicitis with septic thrombi in the appendicial vein that are unsuspected, and in which ligation of the mesentery during the removal of the appendix localizes the thrombus.

In a certain number of cases, however, a telltale pre-operative or postoperative chill gives warning of an existing thrombus and points to further procedures which should be attempted in order to stop any further septic emboli from being thrown off. Should the process progress unhindered, it may take one of two forms. More emboli may reach the liver, causing localized multiple septic areas and leaving the portal system comparatively free except for the small radicles about the appendix from which the trouble started. Or there may be marked inflammation of parts of the portal system, pylephlebitis, with massive purulent thrombi involving the ileocolic and right colic veins and liver involvement as well. Much of the literature on this subject deals with such cases or cases encountered at necropsy.

The first description of a case of appendicitis followed by pylephlebitis and liver abscesses is attributed by Loisson to Waller, in 1846. Other occasional reports occurred sporadically over the next half century. Such articles were based entirely on the description of necropsy findings. In 1900, however, Deaver wrote, "The pylephlebitis is sometimes of the mild or non-infectious variety; frequently, however, the process is infectious; the thrombus becomes purulent, and leads first to abscess of the liver and subsequently to general infection with pyemia." He cites the cases of several patients who developed liver abscesses and in each of whom there was a history of repeated chills. Later he stated, "Chills are a rather uncommon occurrence in appendicitis, yet if at the onset of the attack they occur in rapid succession, and are accompanied by temperature, they indicate a rapidly developing gangrene of the appendix. Chills occurring on the second or third day of the attack and associated with high fever usually indicate the development of metastatic or embolic abscesses." Kelly, writing 5 years later said: "Chills are exceptional in cases of simple diffuse inflammation, but are not rare with severe lesions. Of the patients with acute appendicitis not associated with abscess or general peritonitis admitted to Johns Hopkins hospitals, 15 per cent of them gave a history of chills, and in all of these, with the exception of two, the appendix was gangrenous, perforated, or distended with pus. Repeated chills occurring later in the course of the malady generally indicate a dissemination of the pyemic process." Thirty years ago, it would appear that these surgeons had practically recognized the disease entity of which we speak. They associated the condition with a gangrenous appendix in which dissemination of the purulent process into the portal system had taken place.

Individual case reports of liver abscesses following acute appendicitis and complicated by chills were cited by Bletchly, Bidwell, Brogden, and Cantab. Gerster, in 1903, suggested opening and draining the portal vein when it was found to contain a septic thrombus secondary to acute appendicitis. This procedure was the first operative interference to be suggested. It proved to be impracticable, however, because if the process extends this far, death is inevitable. Wilms, in 1909, cited the first case successfully treated by ligation of the venous radicles of the portal system. He stated, "On the second day a severe chill with high temperature occurred; three chills took place on the third day, and one on the fourth. Two hours after the last chill a second operation was performed. Upon exposure of the ileocecal region, the finger was introduced behind the ascending colon, thus freeing the beginning of the large intestines and the end of the ileum from the posterior parietes. After division of the posterior leaf of the mesentery into an oblique line between the ascending colon and the lower ileum, the

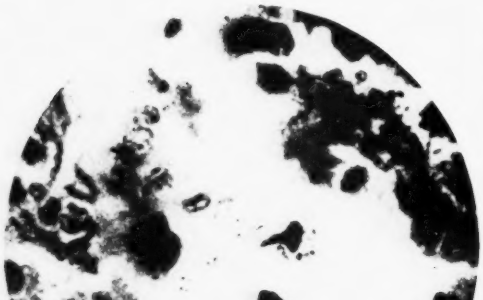


Fig. 1. Bacteria in appendicial vein thrombus. (Gram-Weigert stain, × 1200—Thalhimer.)

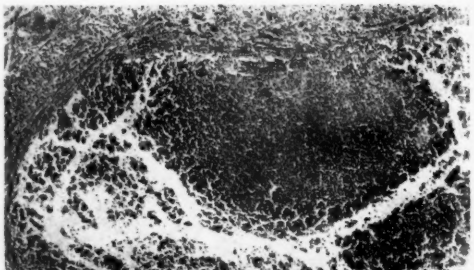


Fig. 2. Thrombus in vein of mesenteriolum. The thrombus is lamellated in one place and purulent elsewhere. (Hematoxylin and eosin stain, × 250—Thalhimer.)

vessels could be recognized. Two small arteries, which were particularly prominent, were isolated, to guard against their being included in the subsequent ligature. Two mass ligatures sufficed to tie off all the veins in this locality. No subsequent chill occurred. The patient made a smooth and uneventful recovery." Sprengel, in 1911, reported a similar case in which a gangrenous appendix was removed and chills developed on the eighth day after operation. With Wilms' success in mind, secondary ligation was attempted 4 days later, after two more chills had occurred. This operation was technically more difficult because a localized adhesive peritonitis was found binding the ileocecal region to the retroperitoneal tissues; ligation, however, was finally accomplished. The patient died 3 weeks after the second operation, having had frequent rigors in the interval. Necropsy revealed, in addition to a localized focus of infection in the right iliac fossa, pylephlebitis of the superior and inferior mesenteric veins. The liver contained multiple abscesses of varying sizes. In the 1911 volume of *Progressive Medicine* (25) this statement occurs: "Pylephlebitis occurring as a sequel of appendicitis has attracted attention for the past 20 years or more. Fortunately, its occurrence in the vast number of acute inflammations is rare. The mortality is very high. Symptoms pointing to its presence usually begin some time after operation, generally during the second or third week.

"The outlook for cure of this condition by operation is, naturally, not brilliant; for by the time that the first chill and high temperature indicate the presence of this condition, the entire portal system may be hopelessly involved. Nevertheless, in so hopeless a condition, it seems fair to afford a patient the chance that operation offers for even if only a majority of the infecting thrombi can be disposed of, it is conceivable that the system may be sufficiently relieved thereby to cope successfully with the remainder."

Braun, following Wilms' technique, tried ligation of the ileocolic vein unsuccessfully. Later, in 1913, he reported two successful cases. Neuhof experimented on dogs by ligating the portal vein, having in mind its possible application in the treatment of suppurative pylephlebitis. He found that complete ligation is immediately fatal, and advocated ligation of individual branches at different times to allow a collateral circulation to form. He

concluded that, in view of the inevitable fatality of suppurative pylephlebitis, such a radical procedure should nevertheless be attempted and if done in steps the ligation would not kill the patient. Eight years later Christopher recorded the case of a patient in whom the symptoms and signs simulated lung abscess as indicated by chills, sweating, and general prostration apparently arising from changes within the chest; there were no localizing abdominal symptoms. After unsuccessful attempts at treatment of the suspected lesion in the chest, death occurred, and necropsy revealed multiple abscesses in the liver arising as a result of a retrocecal gangrenous appendix with pylephlebitis.

In 1924 Thalhimer reviewed the subject and reported 4 cases which he had observed. His paper, although of great importance, has received scant attention. He attempted to show that this grave clinical entity is overlooked by many surgeons. He drew a complete picture of the condition and laid particular emphasis on pre-operative chills as important in selecting operative procedures to check the spread of pylephlebitis. He advocated inspection of the veins leading away from any necrotic appendix, and, if any thrombi were found, ligation of the veins above the thrombus at the ileocecal junction and around the caput coli. In 1926 Colp (10) again drew attention to the subject and cited 3 cases in which patients were treated by high ligation of the portal or superior mesenteric veins. He concluded that high portal ligation was of no avail as the condition, if it had progressed that far, was hopeless. It is interesting to note that all of these patients survived the immediate effects of the portal interruption, but finally died as a result of liver abscesses.

INCIDENCE

Colp (11), in analyzing 2,841 cases of acute appendicitis, noted a chill as a symptom before operation in 6.8 per cent of all cases. Kelly and Hurdon found a history of chills in 15 per cent of cases. Fitz, in 1886, tabulated his necropsy findings in patients dead of acute appendicitis and found pylephlebitis in 11 cases of a total of 257 (4.7 per cent). Armstrong, in 1897, found a necropsy incidence of 5 per cent in 546 examinations. Gerster, however, found only 9 such cases with pylephlebitis occurring in 1,187 cases of acute appendicitis. Braun (3) reported 8 cases in 600 patients; Moschcowitz, 7 cases in 1,529 patients; Gatch and Durman, 1 case in 262 patients, and Giertz 4 cases in 533 patients suffering from acute appendicitis. Petern, in a series of 1,340 necropsies in subjects dead of acute appendicitis, found liver abscesses in 5 per cent. In a recent study of 1,463 consecutive cases of all types of appendicitis, covering a 10 year period at the Newark City Hospital, there were 12 cases with 4 deaths. Other later statistics also show a lower incidence. This is due to earlier operative interference in acute appendicitis. With careful questioning, however, more patients with pre-operative chills will probably be found who never go into the later stages because the appendix with the thrombus is removed early.

PATHOLOGY

This type of fulminating appendicitis is attributed to the streptococcus. Thalhimer shows several pictures of bacteria in a vein thrombus (Figs. 1, 2) but he does not report any cultural studies to determine what type of micro-organism was present. The appendix is either acutely inflamed or gangrenous with a friable mesenteriolum in which the veins are thrombosed. Bier cites a case in which he found streptococci in the portal vein while the appendix showed but little inflammation. In the cases cited in this paper, however, the pathological changes in the appendix were advanced in every instance. If the septic thrombus is not removed or isolated when the appendix is removed, the thrombus extends upward. Sooner or later a small septic embolus may break off and, passing by way of the portal system, lodge in the liver, leaving the portal vein and most of its tributaries free. Thus, the ileocolic vein may be explored and found to bleed freely, containing no thrombus. Nevertheless, the radicles of the same vein may contain infected thrombi distal to the point of inspection and they may continue to be discharged into the liver unless the vein is ligated (Case 9). At times there may be a massive thrombus in the portal

system extending almost to the liver. In such a case, along the course of the vein, small localized abscesses may be formed due to perivenous infection. Until the liver is riddled with abscesses and its venous drainage has become thrombosed, the general systemic circulation may remain free of bacteria. Positive blood cultures are rare, as are lung abscesses secondary to liver abscesses. Empyema of the right chest by direct extension from a liver abscess is more common. There are some cases of jaundice due to liver destruction. Often a subicteric tinge is present. This change usually occurs later in the progress of this disease.

Another possible course for the infection to travel is through the lymph channels that lead to the liver, diaphragm, and subhepatic spaces. This avenue is probably more important in producing perihepatic and subdiaphragmatic abscesses. Most investigators, however, place little stress on the part played by the lymphatic channels or do not consider them at all.

Changes in the peritoneum vary with the stage of infection. In an advanced case of pylephlebitis with massive clotting in the portal system there is usually an adhesive inflammatory process with edema of retroperitoneal tissues and regional lymph nodes. In other equally severe cases, on the contrary, the peritoneum may appear to be only slightly involved.

Sonnenburg believes that in all acutely inflamed appendices there are thrombosed venous radicles but that the virulence of the infecting micro-organisms is not sufficient to overcome local resistance and the affected radicles are removed early enough in most cases to preclude further development.

SYMPTOMATOLOGY

The patient usually gives a clinical history indicative of acute appendicitis. However, in addition, careful questioning is apt to elicit history of a chill which may have seemed so unimportant to the patient as to pass unnoticed. Even when a chill has occurred, the patient often attributes it to some condition other than that of his immediate illness. The thermal reaction of the body is similar to that caused by the streptococcus elsewhere. Usually, even at the outset, the high elevation of the temperature is in strong contradistinction to that of other types of acute appendicitis in which severe local disease of the appendix may cause less than a degree of fever. Another important clinical observation is that these patients, as a rule, are more severely prostrated than in the usual type of acute appendicitis.

DIFFERENTIAL DIAGNOSIS

The most common condition to be confused with this disease is kidney infection or ureteral block on the right side. In this latter condition a chill may occur, but while the kidney region, or right flank, may be tender, the signs of acute intra-abdominal inflammation are absent. Suspicion of early pneumonia with chill, prostration, and occasionally reflex abdominal muscle spasm may be entertained, and the diagnosis between the two may be difficult, although in acute appendicitis the lower right quadrant signs are usually easily detected early in the disease. If the patient is seen late, the picture may be confusing because some of the signs may then have shifted to the upper right quadrant. In such circumstances liver or gall-bladder disease or a subdiaphragmatic or liver abscess of different etiology may have to be excluded. Other possible confusing conditions that should be mentioned are right-sided pelvic inflammatory disease, acute gastro-intestinal disturbances with chills, and early deep phlebitis of the right lower extremity.

In spite of the foregoing evidence, accumulated over a period of years, some clinicians still believe that a chill associated with symptoms suggestive of appendicitis does not point to appendicial inflammation with thrombus formation and secondary embolism. Some still deny that such an entity exists and attempt to explain the sequence of events by some process other than that of acute appendicitis. It has even been said that a chill excludes the diagnosis of appendicitis. The burden of proof rests on the exclusion of acute appendicitis. It is important to emphasize this point so that the diagnosis may be made early. If there is delay, if only for a few hours,

the damage may have become irreparable, especially, if, in the interim, septic emboli have lodged in the liver. It is possible that the liver can overcome a small dose of infected material, but a large dose is almost certain ultimately to cause death in spite of all therapeutic measures.

SURGICAL TREATMENT

Operation is best performed at the earliest possible moment. Spinal anesthesia is the anesthetic of choice, if the patient's condition will allow its use. With this type of anesthetic the viscera are quiet and the abdominal muscles relaxed, permitting a maximum of exploratory possibilities. The right rectus incision with the upper end opposite the umbilicus seems the incision of choice as giving the maximum exposure for exploration. By placing the patient slightly on the left side with a sandbag under the right loin the intestines tend to fall away from the right gutter. After the abdomen is opened the small intestines are packed away with hot sponges to obtain a clear view of the ileocecal junction. The small tributaries of the ileocecal vein may be seen beginning to form a common trunk which runs in the posterior parietal peritoneum in a line drawn from the ileocecal valve to a point in the midline midway between the umbilicus and the xiphoid process. The vein does not continue the whole length of this imaginary line as it empties into the right colic vein just above the umbilicus. It will be found to join the right colic vein just below the third portion of the duodenum. Care should be taken, if there be any question as to anatomical location, to identify this point of juncture and to interrupt the venous return distal to this point, i.e., to ligate the ileocolic vein only. Lying to its medial side throughout its course is the ileocolic artery. The vein thus identified is gently palpated for the presence of a thrombus which, if present, stands out as a stiff, cord-like structure. An attempt is made to follow the vein above the thrombus to a point where the vein has no clot in its lumen. Even though no thrombus be found, the vein should be isolated, ligated, and then severed, the point of ligation being as close to the right colic vein as possible. Walcker (Fig. 3) has

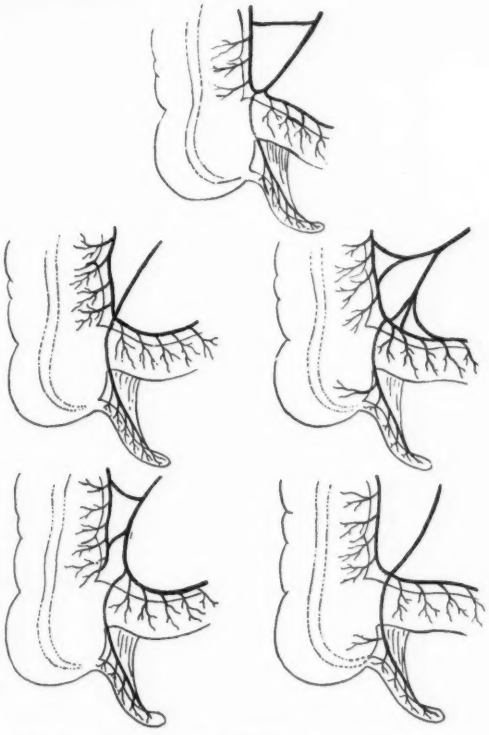


Fig. 3. Anomalies of the venous drainage of the ileocecal angle. (From Walcker, loc. cit.)

pointed out the anomalies of the veins draining the ileocecal region. With these anomalies in mind, a low ligation of the ileocolic vein might fail to prevent further spread of the process into the liver. However, ligation of the ileocolic vein just before it empties into the right colic vein will avoid not including the whole venous drainage of this area even though it should be anomalous. This point of ligation is about 4 inches in the above mentioned line from the ileocecal valve. There is no fear of causing gangrene of the intestine by this procedure. In a certain number of cases the circulation is already obstructed by the thrombus in these veins, and in no case has gangrene been observed. Colp (10) cites several cases of ligation of the portal vein itself without ensuing gangrene. This part of the operation should be performed before the appendix is removed.

At times the process may be so early as to make opening the retroperitoneal space unnecessary. When the thrombus is limited to one small radicle, the appendicial vein may be dissected high behind the ileocecal junction and ligated at this point. Such a procedure has been done in certain cases in which there was no chill, but in which the appendicial veins were found thrombosed at operation. It was also done in several other early cases in this series in which a chill had occurred but the thrombus was found only in the appendicial veins. In the late case with several pre-operative chills such an operation is usually insufficient and only leads to trouble later as the process has advanced beyond the point of attack.

REPORT OF CASES

Twenty-four cases are here presented. For the purpose of accuracy they have been divided into a proved and a presumptive group, although they are all thought to be illustrative of the disease entity under discussion. In these 24 cases the history, presence of a chill or chills, together with definite operative findings of acute appendicitis, all fit into one similar clinical picture. Only proved examples of thrombophlebitis are included in the group to be listed first. In the presumptive group have been listed those cases in which either no thrombus was found or noted in the operative record and those cases in which a thrombus could not be identified because of existing pathology. In several of these cases no autopsy could be obtained to prove the diagnosis.

PROVED CASES

CASE 1. E. S., admitted to Newark City Hospital January 28, 1930; white male, 32 years old; with history of dull, continuous pain in the right lower quadrant for the past 2 weeks. Patient had several acute exacerbations of pain. He vomited once about a week ago. Pain has been more severe in the past few days. He has had chilly sensations on several occasions. Temperature on admission was 100.4 degrees; pulse, 100; respirations, 22. Examination revealed extreme tenderness in the right lower quadrant. Patient did not look extremely ill. Patient was operated upon 2 hours after admission. The abdomen was opened through a McBurney incision. The appendix was gangrenous throughout; the mesenteric vein was thrombosed. The mesoappendix was ligated high and the stump was inverted. Two roll rubber drains were inserted through a stab wound. Patient's course was without note except for an acute bronchitis. He left the hospital on the twentieth day.

CASE 2. C. G., admitted to Presbyterian Hospital December 31, 1930, a 15 year old schoolgirl, gave a history of abdominal pain for past 3 weeks; chills, high fever, increase in temperature, and pain in right lower quadrant, nausea, and vomiting. An icteric tinge to the scleræ was noted; high color to urine. She was brought to the hospital for observation and diagnosis. Temperature on admission, 105.0 degrees; pulse, 130; respirations, 34. Blood count 20,000 with 86 per cent polymorphonuclears. Patient on admission was toxic, somewhat dehydrated. Examination showed moderate tenderness in right lower quadrant with suggestion of a mass the size of an egg, and marked rigidity in right upper quadrant with some tenderness over the liver. Operation was performed January 1, one day after admission, with pre-operative diagnosis of retrocecal appendicial abscess with pylephlebitis. The abdomen was opened through a McBurney incision. A large mass was found surrounding the appendix. The appendix was removed. Two roll rubber drains were placed in the area of the appendix, one Penrose drain in pelvis. The wound was closed in layers. Temperature remained high. On first postoperative day she had a chill followed by one or more chills on the second, third, fourth, fifth, ninth, eleventh, thirteenth, seventeenth, and eighteenth days. Temperature was spiking in character and hectic. Patient was transfused on the ninth day after operation. She continued to complain of pain in the right upper quadrant. In spite of supportive measures and intravenous fluids, course continued downhill with vomiting and abdominal distention. Death occurred on the twenty-second day after operation. Autopsy revealed acute spreading peritonitis secondary to a gangrenous appendix; pylephlebitis of mesenteric and portal vessels, multiple liver abscesses, toxic nephritis and myocarditis, and terminal pulmonary edema.

CASE 3. L. R., admitted to Newark City Hospital October 4, 1931; white male, 28 years old; complaining of cramps and pain in the stomach and in the lower left quadrant for 2 days. Day before admission he took castor oil. On day of admission he had a chill and a high fever. On admission his temperature was 104.3 degrees; pulse, 88; respirations, 22. Operation was performed 1 hour after admission through a right rectus incision. The abdomen showed rigidity in both quadrants with deep and rebound tenderness. No masses were palpable. Rectal examination revealed a mass high just to the right of the midline. It was a curving putty-like mass the size of a pencil. It was tender. Diagnosis was made of acute gangrenous appendicitis with pylephlebitis. The peritoneum was opened and revealed free red-tinged milky fluid. The appendix was found black and ruptured, dipping over the brim of the

pelvis, with thrombosis of the appendicial vessels. The appendix was removed. A thrombosed mesentery was dissected out high above thrombus. Two rolled rubber drains were inserted through a stab wound. Sliver drains under fascia. Patient made a good and uneventful postoperative recovery except for superficial wound infection. He was discharged from the hospital on the twenty-fifth day after operation.

CASE 4. H. H., admitted to the Presbyterian Hospital December 30, 1931; white male, 13 years old; with a history of pain in the stomach for 1 day followed by vomiting and localization of the pain around the umbilicus. He had had one previous attack 2 months ago. Diagnosis of appendicitis was at first ruled out, but in 24 hours the symptoms again recurred and the patient was admitted to the hospital. Ice cap was placed on the abdomen and patient was kept on liquids. On the first day after admission the patient had a severe shaking chill lasting 20 minutes. A consultation was called and an immediate operation was then decided upon. White blood count before operation was 11,500 with 88 per cent polymorphonuclears. A diagnosis of acute gangrenous appendicitis with thrombophlebitis was made. Operation was performed through a lower right rectus incision. Appendix was kinked at its mid-point, the distal half being gangrenous. There was a definite thrombophlebitis of the appendicial vein. Appendicial vein was ligated high above the thrombus, and the appendix was removed in the usual manner. The stump was buried. One Penrose drain was brought through a stab wound. The wound was closed in layers. Patient's course was not stormy. Temperature gradually fell. Large quantities of intravenous fluids were given for 5 days. On the twelfth day after operation there was an unexplained rise in temperature to 101.0 degrees. Patient, however, looked so well that he was discharged from the hospital 2 days later on the fourteenth day after operation.

CASE 5. R. B., admitted to Newark City Hospital January 8, 1933; white male, age 39 years; with a history of being well until the day of admission when he began to have pain around the umbilical region which was sharp and cramplike. It then descended to the right lower quadrant and he began to vomit. He began to feel feverish and came to the hospital; he had a real chattering chill which lasted for several minutes. On admission he had a temperature of 105.0 degrees; pulse, 120; respirations, 28. He complained of pain in the right lower quadrant and on examination he was found to have moderate rigidity and rebound tenderness over McBurney's area. No masses were palpable. Diagnosis of acute gangrenous appendicitis with thrombophlebitis of the appendicial vein was made. He was operated upon 4 hours after admission. His abdomen was opened through a right rectus incision. The appendix was found swollen, edematous, injected, and friable. The veins of the appendix were noted to be everywhere thrombosed. The appendicial vein was followed up the mesentery until it could be ligated above the palpable thrombus. It was then cut and ligated at both ends. The appendix was removed in the usual manner. The stump was buried. The abdomen was closed in layers; no drainage. Patient's temperature dropped from 105.0 to 100.0 degrees within 12 hours. Temperature never again went above 100.0 degrees, and he made a successful recovery unhampered, to be discharged from the hospital on the tenth day after operation.

CASE 6. T. G., admitted to Presbyterian Hospital February 12, 1934; white male, 50 years of age; complained of onset on previous day of slight diarrhea and pain across lower abdomen, with a slight nausea and some vomiting. The pains persisted in the right lower quadrant. The preceding evening he had had several chills followed by a high temperature. He gave no history of previous attacks. Examination showed abdomen to be distended with gas, tenderness and spasticity in the right lower quadrant with rebound tenderness, but no masses. Temperature on admission was 102.6 degrees; pulse, 90. Leucocytes numbered 12,000 with 90 per cent polymorphonuclears. A diagnosis was made of gangrenous appendicitis with pylephlebitis. Operation was done 2 hours after admission through a right rectus incision. A gangrenous appendix with a thrombosed mesenteric vein was dissected high and the vein was ligated above the thrombus. Two Penrose drains were placed through stab wound, one into the pelvis and one into the right gutter. He was given intravenous fluids after operation. Temperature declined uneventfully. Patient made a smooth recovery. He was discharged on the twentieth day after operation.

CASE 7. E. B., admitted to St. James Hospital February 23, 1934; white male, 20 years old; complained of onset of pain across the lower abdomen 3 days previous. The pain was sharp and continuous. He vomited several times. Two days ago he was given a laxative and since then he has had diarrhea. Pain continued to be severe up to admission. He began to feel feverish the day of admission. Two days before admission he also had a shaking chill which lasted about 10 minutes. When admitted to the hospital his temperature was 102.6 degrees; pulse, 102; respirations, 24. He had tenderness and rigidity over the lower abdomen, more in the right lower quadrant. He complained of severe abdominal pain. The white blood count was 28,750 with 87 per cent polymorphonuclears. The urine showed 2 plus albumin. A diagnosis was made of acute gangrenous appendicitis with thrombosis of the appendicial vein. Operation was performed through a McBurney incision, revealing a small amount of clear serous fluid. The appendix, stiff and bound in adhesions from the omentum and the terminal ileum, lay at the pelvic brim. The adhesions were freed. When the mesoappendix was separated down to its base, a hard, bluish, tube-like structure, which was the appendicial vein, thrombosed throughout, was found. The appendix was clamped, tied off, am-

putated, and the stump was inverted. Because of the patient's condition, the thrombosed appendicial vein was not dissected up behind the ileocecal valve, but a ligature was placed above the thrombus. No intra-abdominal drainage was used. Sliver drain was placed under the fascia. Patient had diarrhea for 1 week after operation. He was given large quantities of fluids. On the fourth day he had a severe shaking chill for 10 minutes and his temperature rose to 104.6 degrees. Temperature fell again, immediately after the chill. Temperature gradually returned to normal. On the twelfth day the diarrhea abated and the patient's condition seemed good except that he complained of abdominal pain daily. The temperature remained flat for 4 days more until the seventeenth day when he began to have a temperature rise with an increase of diarrhea. The abdomen was soft but he complained of abdominal pain. Blood count showed 31,250 leucocytes with 85 per cent polymorphonuclears. Stool examination for parasites was negative. He still had two plus albumin in the urine with a few pus cells. Diarrhea was not controlled by bismuth. However, after reaching a peak of 102.0 degrees on the twenty-second day, temperature gradually fell to normal on the twenty-sixth day. From then on he continued to be free of fever and symptomless until his discharge from the hospital on the thirtieth day after operation.

CASE 8. F. A., admitted to Newark City Hospital June 5, 1934; white female, aged 24 years; complained of onset of abdominal pain on the morning of the day before admission. There had been no attacks similar to the present condition. Onset of pain was followed by nausea and vomiting in several hours. Pain was of a sharp and intense character. It soon localized in the right lower quadrant. She had a chill and noticed that she had some fever. Pain then became of sharp character radiating to the upper right quadrant and accompanied by pain in the shoulder. She vomited several times the night before admission. She was thought to be about 8½ months pregnant. A provisional admission diagnosis was made of acute suppurative appendicitis complicating pregnancy. On physical examination she was found to be dehydrated, and dyspneic with slight cyanosis. Temperature was 101.6 degrees; pulse, 134; respirations, 40. The abdomen was found symmetrically enlarged, the uterus extending midway between the umbilicus and the xiphoid. Position of the child was determined as left occiput anterior. The child was alive with a strong regular heartbeat of 134 a minute. There was direct and rebound tenderness over the entire abdomen, especially the right lower quadrant. Moderate rigidity was found all over the right side of the abdomen. White blood count was 17,400 with 88 per cent polymorphonuclears. A diagnosis of retrocecal gangrenous appendicitis with pylephlebitis was made. She was given 1,000 cubic centimeters of saline solution before operation. Operation was done through a high McBurney incision. When the peritoneal cavity was opened free purulent fluid, with a strong Bacillus coli odor, welled into the wound. The uterus, which encroached on the medial side of the wound, was walled off with a warm sponge. The cecum was found lying high out of the right lower quadrant just in the upper quadrant. The appendix was gangrenous, bound down, and in a retrocecal position. A large fecolith was found lying free in the abdomen. An attempt to invert the stump was not entirely successful due to the position of the appendix. The appendicial vein was ligated high above a thrombosed mesentery. Two Penrose drains were placed in the right gutter through a stab wound. Several sliver drains were placed under the fascia. Because of the pregnancy a duodenal suction drainage as a prophylaxis against expected abdominal distention was started immediately. She was given fluids by vein and under the skin. General postoperative course was not so stormy as might have been expected. Distention was quite easily controlled. On the sixth day she showed slight vaginal spotting with no pain. This was the only sign of possible interruption of the pregnancy on this admission. The wound drained freely of thick, foul, Bacillus coli pus, the drainage gradually diminishing to a scant spotting at the time of her discharge from the hospital. She was allowed out of bed on the fourteenth day and was allowed to go home on the eighteenth day with the advice to go home and remain in bed. However, 2 days later she was admitted to the obstetrical ward in early hard labor. She was delivered 9 hours later of a living normal child. Following the delivery of the placenta there was a moderate quantity of foul-smelling purulent material expressed from the vagina. A culture of this material and a direct smear both showed a gram positive diplococcus. The puerperium was uneventful except for a rise in temperature to 100.4 degrees on the third day. Blood Wassermann was negative. She again left the hospital on the tenth day postpartum.

CASE 9. D. D., admitted February 2, 1935, to Newark City Hospital; white male, aged 30 years; with a history of developing continuous sharp pain about the umbilicus on the day before admission, with nausea and vomiting. The pain shifted to the right lower quadrant. There was no history of any previous attacks. On the day of admission patient had a severe shaking chill which lasted about 10 minutes. Temperature on admission was 100.4 degrees; pulse, 100; respirations, 26. He had direct and rebound tenderness over McBurney's point with some rigidity. White blood count was 18,200 with 89 per cent polymorphonuclears. Diagnosis was made of acute gangrenous appendicitis with thrombophlebitis, and operation was performed 4 hours after admission. Because a mass was thought palpable in the right lower quadrant, a McBurney incision was made revealing marked localized adhesive and purulent peritonitis surrounding a gangrenous appendix. Although pylephlebitis had been suspected, no extensive operation was performed be-

cause of fear of spreading the virulent process throughout the abdomen. The appendicial vein was, however, exposed as high as possible and ligated. One Penrose drain was placed through a stab wound. After operation he had a cough, productive of thick, tenacious mucus. It seemed to clear up within 3 or 4 days with medications. On the fifth day he had a slight chill with temperature of 104.2 degrees, and another on the tenth day. He was given large quantities of fluids by hypodermoclysis. He continued to vomit in spite of duodenal suction drainage through a Levine tube. His condition seemed poor. He began to cough and expectorate repeatedly. He vomited intermittently. There was but little drainage from the stab wound. The wound was healing well and seemed clean. This general picture continued until the third week when he seemed to be gradually improving. On the twentieth day after operation he had a severe shaking chill with a temperature elevation to 105.0 degrees. The next day he received a transfusion of 500 cubic centimeters of blood. He seemed much weaker. His vomiting and abdominal pain returned. He again had another chill 2 days later. Secondary exploratory operation was done on the twenty-fourth day through a long right rectus incision, revealing free, thin reddish fluid in the abdomen. No pocket of pus was encountered. All of the mesenteric glands were enlarged. The pancreas and liver were enlarged. On the dome of the right lobe of the liver, 3 hard nodules were palpable. The ileocolic vessels were explored and opened. They bled freely showing there was no massive thrombosis. Diagnosis was made of multiple liver abscesses. He received a transfusion the next day together with intravenous fluids. He continued to vomit. A Levine tube was again inserted. He received another transfusion on March second, and on the same day 6 hours after the transfusion he had another severe chill, followed by another one on the next day. Successive blood cultures taken at this time were negative. X-rays of the chest were negative until April 6, when the dome of the right diaphragm seemed raised. He had been having chills on and off every few days with few other signs in the abdomen except right upper quadrant tenderness. On April 9 he was taken to the operating room again and the twelfth rib resected in the midaxillary line in order to drain a subphrenic abscess and a contiguous liver abscess. Blood cultures remained negative throughout. He continued to have chills. His condition did not improve. He continued to appear weak and listless in spite of continued transfusions and other supportive measures. He vomited frequently. He went downhill gradually and on April 24, he died, 81 days after admission. At autopsy there was found a slight icteric tinge to the scleræ. Otherwise, the autopsy was essentially negative except for the abdomen. The lower part of the abdomen contained straw colored fluid. There was a purulent plastic exudate of the lower abdomen. There were fresh adhesions of the superior surface of the liver to the diaphragm. Small amount of purulent fluid was found over the right lobe of the liver. There was extensive plugging of the portal vein at the hilus of the liver with a purulent organized thrombus. The left lobe of the liver was practically free of abscesses. The right lobe of the liver was riddled with discrete confluent abscesses which contained creamy, thick, yellow, foul pus.

Case 10. L. B., admitted to Presbyterian Hospital June 2, 1935; white male, 39 years old; with a history of having chills and fever every night for the past week but no symptoms during the day. Patient went to work during the day; at night he felt chilly and had a chill. Several nights previous he vomited. He had had no pain to speak of since the beginning of his illness. On admission to the hospital he had a temperature of 101.4 degrees; pulse, 88; respirations, 22. White blood count was 10,000 with 80 per cent polymorphonuclears. On examination he did not seem acutely ill. He was slightly dehydrated. There was some tenderness in the right lower quadrant with moderated rigidity of the right rectus muscle. A kidney infection on the right side was considered as the probable diagnosis for the first 24 hours in the hospital because a urinary examination erroneously reported the presence of a large number of leucocytes. After this possibility was ruled out by subsequent urinary examinations, operation was decided upon to determine whether the pathology arose from the appendicial vein as was then suspected. Operation was done with spinal anesthesia through a right rectus incision 5 inches long. An appendix gangrenous at its tip was found. The mesentery of the appendix was edematous and contained hard, cord-like veins. Palpation of the ascending ileocolic leaf of the mesentery revealed an edematous, ecchymotic mass extending upward, which was identified as the ileocolic vein. The mesentery of the ascending colon was separated by blunt dissection and the ileocolic vein was ligated high, about 6 inches above the ileocecal valve. The appendix was removed, the stump inverted, and the abdomen was closed in layers. A sliver drain was placed under fascia. At the time of operation his temperature was 104.0 degrees. Following the operation his temperature continued to be high. For 43 days he continued to have a spiking temperature going to 106.0 and 107.0 degrees following rapid and frequent chills which occurred sometimes twice a day. He received intravenous fluids and multiple small blood transfusions. The abdominal wound was well healed. His abdomen did not become distended. His chills later became more violent in character, some lasting as long as 55 minutes. He died 44 days after admission. Autopsy revealed the abdominal cavity to contain a considerable amount of clear fluid, about 4 liters. There were a large number of adhesions between the intestines and the gall bladder. In addition, there were pus pockets containing thick greenish pus on the right side of the abdomen. The mesentery contained a large amount of pus in areas extending along the mesen-

teric vessels. There were abscesses along the portal vein. The liver was enlarged, congested, and the left lobe was practically gone, being replaced by a large abscess containing thick green pus. The right lobe contained small abscesses scattered throughout, apparently along the veins. The spleen was tremendously enlarged, dark, and soft.

CASE 11. W. B., admitted to Presbyterian Hospital August 23, 1935; white male, 43 years old; complained of sudden pain in the epigastrium beginning the day of admission. Pain soon descended to the right lower quadrant. Nausea followed and had persisted to admission. About an hour before admission he had a chill. Examination on admission showed a well developed adult male apparently acutely ill and suffering pain in the lower abdomen. There was direct and rebound tenderness over McBurney's point. Temperature was 101.4 degrees; pulse, 96. A diagnosis of gangrenous appendicitis with pylephlebitis was made. Operation was done within 1 hour after admission, through a lower right rectus incision. The appendix was brought into the wound. The mesoappendix was ligated high above a thrombosed appendicial vein. The appendix was removed in the usual manner; no intra-abdominal drainage. Sliver drain was inserted under the fascia. Patient was given intravenous fluids and sedatives. Postoperative course was uneventful. Was discharged on the twelfth day after operation.

CASE 12. C. M., admitted to Newark City Hospital October 13, 1935; colored male, 32 years old; was placed on the medical service, with a diagnosis of pyelitis. Past history was essentially negative. Present history states that he was out drinking 10 days ago and came home drunk. The next day while at work he had some slight abdominal pain which cleared up after an hour or so. He continued at his work. After leaving work he went to bed as he did not feel well. That night his doctor ordered salts and cream of tartar for the patient. Two days after the onset, and soon after he took the cathartic, the patient felt nauseated and vomited once. He has also vomited once since then. For the past 8 days he has been having chills, about 2 a day. He has been feeling feverish all this week. He now has some pain and tenderness in the right upper quadrant. On admission, his temperature was 103.0 degrees; pulse, 88; respirations, 24. White blood count was 8,900 with 82 per cent polymorphonuclears. The urine showed a specific gravity of 1.022 with trace of albumin. Another specimen was positive for bile. The scleræ looked slightly jaundiced. The abdomen was distended but no masses were palpable. There was tenderness over the costal border in the right upper quadrant. Diagnosis while on the medical service was possible pyelitis, possible septicemia, and possible typhoid fever. Two days after admission the white blood count had risen to 13,200 with 84 per cent polymorphonuclears. Four days after admission the medical service made a diagnosis of subdiaphragmatic pleurisy with abscessed liver, the etiology being: (1) mesenteric thrombosis, (2) pylephlebitis from acute appendicitis, (3) ruptured gastric ulcer. A surgical consultation was called and a diagnosis made of pylephlebitis secondary to acute appendicitis. He was transferred to the surgical ward and on October 18, 5 days after admission, was operated upon. The abdomen was opened through a right rectus incision. The peritoneal cavity contained a moderate amount of free straw-colored fluid. There was a great deal of edema of the mesentery and the mesenteric glands were palpable. There was a mass consisting of appendix and omentum in the right lower quadrant. The appendix was retrocecal. It was removed with the cautery and the stump was inverted with a purse-string. One inch from the base of the appendix along the ileocolic vessels there was an abscess cavity containing foul-smelling pus. One inch proximal to this point and parallel with it was another abscess cavity. The ileocolic vein was ligated 3 inches from the appendix and ileocecal angle. No thrombus was found at this point. Two drains were placed through a stab wound into the right gutter and abscess cavities. The wound was closed in layers. Patient was given large amounts of fluids after operation. He continued to have severe chills and temperature shooting up to 105.0 degrees. He went steadily downhill, dying 2 days after operation and 1 week after admission to the hospital. Autopsy revealed multiple liver abscesses, suppurative abscesses along the course of the ileocolic and portal vein, with thrombosis of the portal vein at its entrance to the liver. There was marked liver destruction by abscess formation.

CASE 13. W. S., admitted to Newark City Hospital October 26, 1935; 15 year old white male; assigned to the Surgical Service with complaint of abdominal pain which had started 2 days previously and which had begun with cramps around the umbilicus. Patient had vomited nine times since the onset. The pain shifted to the right lower quadrant. There had been loss of appetite and the bowels had become irregular. On day of admission, in the morning, he had a chill. The day the pain began he took a strong cathartic and an enema. Temperature on admission was 103.6 degrees; pulse, 120; respirations, 20. A diagnosis was made of a ruptured appendix. The abdomen was rigid throughout with direct and rebound tenderness more in the right lower quadrant. Patient was operated upon 4 hours after admission, through a McBurney incision. The peritoneum was opened and revealed pus in the abdomen. A ruptured gangrenous appendix was found covered with omentum and fibrin. A thrombus could be palpated in the appendicial mesentery. The appendicial vein was ligated high above the thrombus. The appendix was removed and the stump inverted. Two Penrose drains were placed through a stab wound. The abdomen was closed in layers with clips in the skin. The postoperative course was uneventful except for profuse purulent drainage from the wound, the temperature dropping to normal after the first week.

CASE 14. H. S., white male, aged 63 years, was admitted to the Presbyterian Hospital on January 7, 1936, with a history of having had an attack of lower right quadrant pain 4 days before admission. He was nauseated and vomited. Two days after it started he took a cathartic. For the past 2 days the pain has been more severe and has remained in the right side. He has been unable to eat. There is no history of a chill. On admission he had a temperature of 102.4 degrees; pulse, 80; respirations, 28. He was dehydrated; not in any apparent acute distress at present or complaining of severe pain in the right side. Examination was essentially negative except for the abdomen which was soft except in the right side where there was direct and rebound tenderness and also a small palpable mass in the right lower quadrant. A pre-operative diagnosis was made of acute appendicitis with thrombophlebitis. Operation was performed through a lower right rectus incision 1 hour after admission, and revealed a gangrenous appendix which was perforated at its base. The appendix was removed and the stump was not inverted. The abdomen contained thick purulent fluid which was aspirated. Two Penrose drains were inserted and brought out through a stab wound. The wound was closed in layers, leaving one sliver drain under the fascia. The patient apparently made an uneventful recovery for the first 17 days. The wound drained a great deal of thick pus. On the eighteenth day one Penrose drain was removed and approximately 12 hours later he had a severe, shaking chill. He was apparently comfortable and without complaint until the chill occurred. The temperature rose to 102.0 degrees. Patient vomited after the chill. He had another chill that evening lasting 30 minutes with a temperature of 103.0 degrees. On the twenty-third day after operation another Penrose drain was removed; it was followed in 7 hours by another severe chill lasting 20 minutes. He complained of feeling chilly the next day and the following day he had another severe chill. The next 6 days he had successive chills with temperature rises up to 105.0 degrees. On February 8, 32 days after his appendectomy, he was again operated upon and a ligation of the ileocolic vein about 4 inches above the ileocecal valve was performed through a right rectus incision opposite the umbilicus. Duration of the operation was 45 minutes. Exploration of the abdominal cavity was not done. The ileocolic vein on section bled freely. For 2 days after the vein ligation the patient's temperature remained normal. On the third day after this operation he had three severe chills and until the date of his death, 45 days after the original operation, he had at least one chill and high temperature rise each day. Blood cultures on several occasions showed a growth of non-hemolytic streptococci. Autopsy showed a liver with one large abscess and several small abscesses; along the course of the portal vein there were small abscesses with a large thrombus almost filling the portal vein. The area of ligation was explored and distal to the point of ligation the small veins were found thrombosed, but the intestine in this area was not affected by this interruption of the blood supply. There were multiple small abscesses also in the lungs.

CASE 15. W. T., white male, age 43 years, was admitted to St. Mary's Hospital, Orange, June 28, 1936, with a history of having been awakened from his sleep early on the morning of admission with severe abdominal discomfort. The pain was relieved after defecation only to return in several hours. The pain remained generalized in the abdomen most of the day. Toward evening it centered in the right lower quadrant. Just previous to admission patient had a shaking chill followed by another after admission. On admission patient's temperature was 102.0 degrees; pulse, 98; respirations, 20. Physical examination was essentially negative except for a moderately rigid abdomen with considerable rebound tenderness. The pre-operative diagnosis was acute appendicitis with thrombophlebitis. He was operated upon 5 hours after admission, by Dr. A. J. Ganley, through a McBurney incision. A gangrenous appendix was found. No free abdominal fluid was present. The appendix was removed, the mesentery of the appendix was ligated high, and the abdomen was closed without drainage, one sliver drain being placed under the fascia. The temperature fell to 100.0 degrees on the first day after operation and remained normal after the fourth day. He made a completely uneventful recovery except for catarrhal conjunctivitis, to be discharged from the hospital on the eleventh day after operation. Microscopic pathological examination report reads: "The mucosa of the appendix is necrotic and purulent. Scattered throughout the edematous walls are polymorphonuclears. On the external surface is noted fibrinopurulent exudate. The meso-appendix shows clots within the lumen of the blood vessels."

CASE 16. F. M., white female, age 40 years, was admitted to the Presbyterian Hospital on October 11, 1936, with a history of abdominal pain which has been generalized for the past 36 hours. She has felt nauseated but did not vomit until the day of admission. The morning of admission the pain localized in the lower right side and she had a severe, shaking chill which lasted several minutes. Examination on admission revealed tenderness and rigidity all over the lower abdomen with rebound tenderness on the right side. Temperature was 100.2 degrees; pulse, 100; respirations, 20. She was operated upon soon after admission through a lower right rectus incision; an acutely swollen appendix, which was gangrenous, was found. There was no free fluid in the peritoneal cavity. When the mesoappendix was separated practically no bleeding occurred. The veins in the mesoappendix were found thrombosed and were ligated high behind the ileocecal valve. Two Penrose drains were inserted through a stab wound; the incision was closed in layers. Large amounts of thick purulent fluid drained from the wounds. The patient made a continuous progressive recovery. Her temperature was normal on the eighth day after

operation. Pathological report on the appendix was acute gangrenous appendicitis with thrombophlebitis. She was discharged from the hospital on the twenty-first day after operation. Drainage had stopped and her general condition was very good.

PRESUMPTIVE CASES

CASE 1. A. L., admitted to Newark City Hospital August 10, 1927; white female, aged 32 years; complained of weakness for 5 days, with pain in the back and general malaise. Three days ago she had a chill; she felt feverish and began to have pain across the lower abdomen. The pain soon radiated more to the right side in both upper and lower quadrants. Several hours later she had a vomiting attack and has had several since then. Temperature on admission was 104.6 degrees; pulse, 120; respirations, 44. Examination revealed that the abdomen was everywhere rigid, more on the right side with direct and rebound tenderness. No masses were noted. White blood count was 16,200 with 87 per cent polymorphonuclears. Diagnosis was made of an acute surgical abdomen with peritonitis secondary to an acute appendix. Operation was performed 4 hours after admission, through a right rectus incision. Free purulent fluid was found in the region of the appendix, which was thick and acutely inflamed. The appendix was removed. Two drains were inserted through a stab wound, and 4 sliver drains under fascia. She made a good surgical recovery from the operation, but she developed a chest complication with a cough and an area of apparent consolidation at the right base. This cleared up slowly and she appeared to have an area of unresolved pneumonia. After prolonged rest in bed, the right chest cleared and patient was discharged from the hospital on the forty-fifth day after operation.

CASE 2. W. E., admitted to Newark City Hospital October 12, 1927; white male, 10 years old; with a history of generalized abdominal pain which radiated to the right lower quadrant, for 3 days. The pain has persisted, he vomited and was given cathartic day after pain started. The next day he had a chill. He has had earaches for the past several weeks with discharging ears for several days. On admission the abdomen was very rigid, board-like, with direct and rebound tenderness throughout. Temperature on admission was 101.6 degrees; pulse, 120; respirations, 36. The white blood count was 12,600, with 86 per cent polymorphonuclears. Diagnosis was made of ruptured appendix with acute otitis media. Operation was performed 4 hours after admission, through a right rectus incision. A moderate amount of free green purulent fluid was found. The appendix was gangrenous. The appendix was removed in the usual manner, the stump buried, and 2 Penrose drains were inserted through a stab wound, with sliver drains under the fascia. After operation the child continued to improve. The ear condition cleared up with irrigations. Patient made a smooth, continuous recovery, to be discharged on the twenty-sixth day.

CASE 3. J. F., admitted to Newark City Hospital January 2, 1929; white male, 28 years old; complained of pain and vomiting almost continuously for the past 2 days. Pain at first was generalized but now is confined to the right lower quadrant. Yesterday he had a profuse sweat followed by a 15 minute shaking chill. He has felt severely prostrated. Temperature on admission was 103.0 degrees; pulse, 86; respirations, 26. White blood count was 16,900 with 89 per cent polymorphonuclears. A diagnosis of acute gangrenous appendicitis with pylephlebitis was made. Examination revealed marked rigidity of the abdomen, extreme tenderness throughout, but most marked in the right lower quadrant. Operation was done 2 hours after admission through a McBurney incision and revealed free fluid. The appendix was retrocecal and necrotic throughout. The terminal ileum and cecum surrounding the appendix also showed signs of healing necrosis, with marked edema. The appendix was removed, the stump inverted, and the mesoappendix ligated high. Two stab wound drains, one to the pelvis and one to the right gutter were used. Intravenous and subcutaneous fluids were given for the first 4 days. Foul thick pus exuded from the wound for 2 weeks. Patient's course was stormy, with frequent vomiting and hiccoughing and signs of localized peritonitis. Patient was discharged from the hospital on the nineteenth day after operation in good condition, the wound being healed.

CASE 4. J. J., admitted to Newark City Hospital, March 22, 1930; white female, 16 years old; complained of being seized with pain in the epigastrium. Two days before admission the pain became more severe and was accompanied by vomiting. The day before admission she had several chills. Examination showed a well developed, well nourished girl acutely ill with general abdominal tenderness. Temperature on admission was 101.2 degrees; pulse, 122; respirations, 20. The abdomen was rigid, with rebound tenderness especially in the right lower quadrant. There were no masses and no obliteration of liver dullness. The diagnosis on admission was possible biliary colic with possible pancreatitis. Blood count was 8,000 with 81 per cent polymorphonuclears. The urine was negative. Patient was operated upon 8 hours after admission. A lower midline incision was made and revealed the peritoneal cavity full of buff colored pus. The appendix was removed after ligation of the base. Ileostomy was performed. Three roll rubber drains were placed in the abdomen. The postoperative course was stormy with the development of jaundice. On the second day the patient, in spite of all measures, developed considerable distention and vomiting due probably to peritonitis. There was profuse drainage from the wound on ninth day. Fecal drainage from wound developed, and a definite fecal fistula was established. On the same day bleeding from the wound began, clots of blood appeared from under dressing but no specific bleeding point could be found. Patient's course continued downhill, the

pulse became more rapid and thready, and she died on eleventh day after operation. Final diagnosis was ruptured appendix with pylephlebitis, generalized peritonitis.

CASE 5. J. M., admitted to Newark City Hospital January 4, 1931, 39 year old colored longshoreman, complained of severe abdominal pain around umbilicus which had been present for past week. No nausea or vomiting occurred. Several hours before admission patient had a chill. He has had a high fever during past week. Examination showed an undernourished colored male complaining of severe pain in the abdomen and having definite chill at time of examination. Temperature was 101.4 degrees; pulse, 96; respirations, 34. The abdomen was markedly rigid especially on the right side, with rebound tenderness. A diagnosis was made of ruptured appendix. Operation was performed 1 hour after admission through a lower right rectus incision. Fluid and free pus were noted in the abdominal cavity. A rubber drain was inserted. The appendix was not removed. Patient's temperature continued high. The pulse was weak, rapid, and irregular. Fluids were given freely intravenously. A postoperative chill occurred on third and fourth days. Patient succumbed on fifth day from acute suppurative appendicitis with localized abscess and pylephlebitis of appendicial vein. No autopsy was obtained.

CASE 6. E. G., admitted to the Newark City Hospital October 2, 1935; white male, 26 years old; gave a history of pain in the right lower quadrant since previous afternoon. He had vomited that night and several times the morning of admission. He has been nauseated continuously. There was a history of a similar previous attack in April. Patient had a chill the previous evening and another chill immediately after admission. Temperature on admission was 104.8 degrees; pulse, 124; and respirations, 26. Examination showed direct and rebound tenderness all over the lower abdomen, with some rigidity. No masses were palpable. White blood count before operation was 21,250 with 94 per cent polymorphonuclears. A diagnosis was made of acute gangrenous appendicitis with thrombophlebitis. He was operated upon 8 hours after admission by Dr. C. MacArthur. Operative note reads: "Low right rectus incision; rectus muscle pushed aside medially and peritoneum was opened at its lateral border. Appendix was found gangrenous, firmly adherent, firmly surrounded by fresh adhesions. The ileocolic vein and its tributaries were opened and examined for the presence of thrombi. All appeared normal. The ileocolic vein was ligated about 4 inches above the ileocecal valve. Appendix was then freed with difficulty and removed. Stump inverted. Abdomen closed in layers. Two sliver drains under fascia." Fluids were given intravenously after operation. Within 24 hours the temperature fell to 100.0 degrees. He made an uneventful recovery except for symptoms of acute bronchitis, a few fine râles being found at both bases. Patient was discharged on the twenty-first day after operation.

CASE 7. J. T., white male, age 42 years, was admitted to St. James Hospital on October 13, 1936, with a history of having had a dull ache in the right side of the abdomen for the past week. The day before admission the pain became severe; he vomited once. He took a cathartic and an enema, and treated himself with moderate amounts of whisky for the pain. The night before admission he had a chill lasting several minutes. On examination there was found slight rigidity in the right lower quadrant. A soft mass was noted in the right side which was acutely tender, with rebound tenderness. Temperature was 101.4 degrees; pulse, 98; respirations, 24. He was operated upon 1 hour after admission, through a McBurney incision. A gangrenous appendix was found wrapped up in omentum. The appendix was removed, the stump was inverted, and the mesoappendix was ligated high. One Penrose drain was placed in the pelvis through a stab wound. The patient had no further chills. He had a stormy course for 12 days with temperature ranging up to 103.0 degrees. The temperature was probably due to an acute bronchitis with patchy pneumonia. After the twelfth day his temperature remained normal. He was discharged on the twenty-first day after operation.

CASE 8. H. D., admitted to Newark City Hospital May 10, 1936; white female, 40 years old; with a history of pain in the right lower quadrant for 2 days before admission. She vomited several times after taking a laxative. The day previous to admission she had several shaking chills with fever. She continued to vomit. The abdominal pain became more generalized. She had eaten very little since becoming sick. On admission the temperature was 102.0 degrees; pulse, 110; respirations, 28. Examination of the abdomen revealed marked generalized rigidity and tenderness which was more marked in the right lower quadrant. The urine was negative. A diagnosis was made of a ruptured appendix with thrombophlebitis of the appendicial vein. Operation was performed under spinal anesthesia through a right rectus incision 3 hours after admission. When the peritoneum was opened free purulent fluid welled up. The intestines were packed away with rubber covered sponges, and the ileocolic vein was ligated above its bifurcation about 4 inches away from the ileocecal junction. It was easily identified, and bled freely at the point of ligation. No thrombus was seen. The appendix was then sought and was found to be ruptured and separated from the cecum at its base, lying free in the peritoneal cavity. It was removed after ligation of the mesentery. The stump could not be inverted, but was tied. Three Penrose drains were inserted through a stab wound, one in the pelvis and two in the right gutter. The abdomen was closed in layers with sliver drains under the fascia. Duodenal suction drainage was started as soon as patient reacted. She was given large amounts of fluids intravenously daily. She

was desperately ill from the onset; she was irrational and semicomatose a good part of the time. Abdominal distention could not be controlled by any measures. Her temperature never fell below its pre-operative level and spiked well above that level each day. She died 7 days after operation with a generalized peritonitis. No autopsy was obtained. She had no chills after operation.

STUDY OF CASES

Although the number of cases in this series is small, it is the largest to be presented thus far in which the same principles of treatment have been applied, and may be summarized as follows.

Age, sex, race. A recent study of 1,463 consecutive cases of appendicitis made at the Newark City Hospital (27) may be used for statistical comparison. In this large series of cases covering all types of appendicitis, 81 per cent of the total occurred between the ages of 10 and 40. The average age in the present series is within approximately the same range. The ratio of colored to white is also found to be the same, approximately 1 to 11. In the large series the sex ratio of male to female was found to be approximately equal, whereas in this group the ratio was 3 to 1 in favor of males. It will thus be seen that, unlike the ratio existing in all types of appendicitis, the condition under discussion is more frequent in men than in women. Boyd states that acute fulminating appendicitis is twice as common in the male as in the female. When the sex incidence of acute cases in the large series is studied alone, the disease is found to be twice as common in men as in women (27), concurring with Boyd. Even then, the ratio is not as high as the 3 to 1 ratio found in the 24 acute cases outlined in this paper.

Symptoms. The symptoms in these cases were those of acute appendicitis with abdominal pain which was either generalized or localized in the right lower quadrant and was associated with nausea and vomiting. The length of time between the beginning of symptoms and the time of admission to the hospital was longer in this group of cases, probably because of the chill, which confused the usual clinical picture of acute appendicitis and prevented earlier admission of the patient to the hospital and thus delayed operation. The average duration of symptoms in the patients who died was 5.5 days before operative interference. Four of these patients presented symptoms for 1 week or longer. There is thus a definite relationship between the duration of symptoms and mortality. None of the patients presented obvious complications before operation with the exception of 2, in one of whom pregnancy was advanced (18), the other jaundiced.

Diagnosis. On reaching the surgical service of the hospital, the diagnosis of acute appendicitis with pylephlebitis was made in 18 cases and immediate operations were performed. Of the 6 remaining, the diagnosis of acute appendicitis was made in 4, while immediate operation for acute pancreatitis was proposed in 1 of the others. The sixth case was that of a patient who was in the medical service for 5 days under a different diagnosis until a surgical consultation was called. These facts are cited in order to show that, if the clinical entity now in question is kept in mind, that is to say, the signs of acute appendicitis with a chill, the correct diagnosis is not difficult. It is only when the chill is interpreted erroneously that delay occurs or the wrong diagnosis is made.

Complications. The main complications found in this series were peritonitis, local or general, and liver abscess. Of those that developed a liver abscess, 6 in number, all died. In 4 patients an upper respiratory infection developed, and one patient died although the respiratory condition was not the immediate cause of death. Case 14, of the proved group, deserves special recognition in that there was no pre-operative chill and in that the appendix was removed without the presence of thrombosed veins being noted. The appendix, however, was gangrenous. This man was without symptoms of pylephlebitis for 17 days after operation and was apparently well on the way to recovery, when one of the Penrose drains was moved. Following the moving of the drain he suffered a chill and when another Penrose drain was moved 6 days later again there were chills. The termination was fatal, and liver abscesses were found at necropsy. It is thought that the drains must have been

contiguous to small thrombosed venous radicles and that the trauma caused by moving them dislodged small emboli from within these veins.

Hospitalization. In those patients who recovered, the stay in the hospital was found to be that of the average case of uncomplicated fulminating appendicitis. In most of the fatal cases the patients remained alive for many days after operation. This is not unusual in cases of this nature. They live for many days after operation has been performed, but once the pathology is established they resist all attempts at cure.

Blood cultures. Although there were 8 deaths in the series here reported, and although in most instances necropsy revealed multiple abscesses of the liver, it is to be noted that, although blood cultures were taken in all of them, a positive result was obtained in only one (Case 14), and then late in the disease. The liver apparently acts as a sieve, straining the emboli into its capillary bed. The infected emboli then produce abscesses, but there is no contamination of the general stream until one or more of the abscesses breaks into the circulation. This fact is important since undue weight may be attached to negative blood cultures. In the light of this experience, it has been decided that, in future, a culture of blood from the interrupted ileocolic vein will be taken at the time of operation for study in comparison with systemic blood taken at the same time.

Type of appendicitis. The operative records in 22 of the 24 cases state that the appendix was gangrenous. In 8 of the 22 cases it was also ruptured. In the 2 remaining appendices, in 1 a diagnosis of suppurative appendicitis was made and the other was described as "thick and acutely inflamed."

Mortality. There were 8 deaths in the group of cases here collected, a mortality of 33 per cent. This figure is above the average rate reported from many large clinics dealing with ruptured or gangrenous appendices. There is undoubtedly a relationship between the duration of symptoms and death, and it is probable that the mortality rate can be lowered if the disease is recognized by the physician who first sees the patient.

There are at least two ways in which the factor of delay affects the outcome unfavorably. First, the probability of embolism increases with time. Second, advanced peritonitis makes identification of the site of the thrombus and ligation of the affected vein difficult, if not impossible. Thus, in the 16 proved cases, 5 of the patients died. In 4 of these (Cases 2, 10, 12, 14), the diagnosis was not made until from 4 days to 3 weeks after the onset of symptoms; in the fifth case (Case 9) no satisfactory ligation could be done because of peritonitis. Of the 11 cases in which the patients survived, 1 case (Case 1) was delayed and 10 were recognized early but ligation was satisfactorily performed in all.

SUMMARY AND CONCLUSIONS

1. The occurrence of a chill and typical symptoms of acute appendicitis point to a complicating thrombophlebitis of the appendicial vein.

2. A study is presented of appendicitis complicated by thrombophlebitis of the appendicial vein, with a report of 16 proved and 8 presumptive cases.

3. The treatment consists in ligation of the ileocolic vein above the thrombus before appendectomy is performed.

4. Unless the condition is treated early and the ileocolic vein ligated, emboli may occur, causing either pylephlebitis or liver abscesses.

5. It is believed that early recognition and proper treatment of this type of appendicitis may contribute to lowering the mortality rate of appendicitis as a whole.

I should like to express my appreciation to Dr. E. Zeh Hawkes and Dr. Royal A. Schaaf for their stimulation and counsel in preparing this paper, and for permission to report some of these cases.

BIBLIOGRAPHY

1. Armstrong. Brit. M. J., 1897, 2: 945.
2. Bidwell. Brit. M. J., 1910, 3: 507.
3. Bier, Braun, and Kummel. Operationslehre, vol. 3: 473.
4. Bletchly, C. P. Brit. M. J., 1908, 1: 1164.
5. Boyd, W. Textbook of Pathology, pp. 537. Philadelphia: Lea & Febiger, 1934.
6. Braun. Beitr. z. klin. Chir., 1913, 86: 314.
7. Brogden. Lancet, 1911, 1: 301.
8. Cantab. Lancet, 1919, 1: May 17.
9. Christopher, F. Surg. Clin. N. America, 1093. August 1921.
10. Colp, R. Surg., Gynec. & Obst., 1926, 43: 627.
11. Idem. Ann. Surg., 1927, 85: 257.

12. DEAVER, J. B. A Treatise on Appendicitis, pp. 162. Philadelphia: P. Blakiston's Son & Co., 1900.
13. FITZ, R. Tr. A. Am. Physicians, 1886.
14. GATCH, W. D., and DURMAN, D. C. Ann. Surg., 1924, 79: 862.
15. GERSTER, A. G. Tr. Am. Surg. Ass., 1903, 21: 39.
16. GIERTZ. Ueber akute eitrage Wurmfortsatz Peritonitis. Weisbaden: 1909.
17. HAWKES, E. Z. Surg. Clin. N. America, 1926, 6: 1568.
18. Idem. Am. J. Obst. & Gynec., 1936, 32: 501.
19. KELLY, H. A. Appendicitis and Other Diseases of the Vermiform Appendix, p. 161. Philadelphia: J. B. Lippincott Co., 1905.
20. LOISSON. Rev. d. chir., 1900, 21: 522.
21. Mortality Statistics, Fifth Annual Report, Bureau of Census, Department of Commerce, United States Government Printing Office, Washington, D. C., 1936.
22. MOSCHCOWITZ, A., and E. Arch. f. klin. Chir., 1907, 82: 3.
23. NEUHOF, H. Surg., Gynec. & Obst., 1913, 16: 481.
24. PETERN. Beitr. z. klin. Chir., 1914, 94: 314.
25. Progressive Med., 1911, 2: 137.
26. SONNENBURG. Pathologie und Therapie der Perityphlitis, 1913, vol. 7.
27. SPRAGUE, E. W., et al. Statistical study of appendicitis; analysis of 1463 consecutive cases. (In press.)
28. SPRENGEL. Centralbl. f. Chir., 1911, 2: 33.
29. THALHIMER, W. Arch. Surg., 1924, 8: 685.
30. WALCKER. Deutsche Ztschr. f. Chir., 1922, 168: 354.
31. WILMS. Centralbl. f. Chir., 1909, 30: 104.

THE CONSERVATIVE TREATMENT OF GALL-BLADDER DISEASE

HARRY E. MOCK, M.D., F.A.C.S., CLARENCE F. G. BROWN, M.D., and RALPH E. DOLKART, M.S., Chicago, Illinois

A CRITICAL survey of the medical and surgical management of gall-bladder disease leads to the inevitable conclusion that present day therapy is inadequate. From the surgeon's point of view, the consensus is that if there is any evidence of pathological changes in the gall bladder, the structure should be immediately removed. From the internist's point of view, the use of the low fat, low cholesterol diet in conjunction with catharsis comprises the average conception of the medical management of gall-bladder disease and has remained unchanged as the treatment of choice for the past three or four decades.

We do not concur with either of these generally accepted ideas of gall-bladder management. Cholecystectomy, which for two decades has been the most popular form of surgical treatment, is not always indicated when surgery is performed; neither has it relieved the symptoms in a reasonable proportion of the cases in which it is used. Cholecystostomy has a more definite place in gall-bladder surgery than recent surgical trends would indicate. The fact that roentgenologically functioning gall bladders can be demonstrated after surgical drainage has apparently been totally disregarded. A great majority of patients with low grade right upper quadrant symptoms can be as completely or more completely relieved by proper medical management than by surgery. The inadequacy of the present popular medical management of gall-bladder disease accounts for the dominance of surgical treatment. Medical management, however, based upon the physiological principles of the biliary tract will relieve symptoms and can restore to normal roentgenological functioning, gall bladders which gave pathological findings on previous examination.

The objective of the present study is to correlate conservative surgical ideas with medical opinion guided by recent advances in the knowledge of the physiology of the biliary tract. In our opinion the management of biliary tract disease can never be designated as solely surgical or entirely medical. We believe that there is much to be gained in the knowledge of the disease by the co-operation of clinicians who of necessity see the patients from different points of view.

As one of the chief factors concerned in the production of upper abdominal distress, the pathological gall bladder is of great significance. In a series of 850 patients seen in the gastro-intestinal clinic of the St. Luke's Hospital Out-Patient Department over a 5 year period, the gall bladder was found to be the causative agent in the majority of cases. The results obtained in this clinic on the incidence of pathological changes in the gall bladder in cases of distress referable to the gastro-intestinal tract compare favorably with statistical studies by Davis and Vander Hoof, Bladeford and Droger, and Foster, on over 7,000 patients. Table I shows the results of our findings.

TABLE I.—DIAGNOSES IN PATIENTS COMPLAINING OF UPPER ABDOMINAL DISTRESS—850 CASES

Diagnosis[1]	Cases	Per cent
Gall-bladder disease	239	28.1
Functional nervousness	183	21.6
Gastroduodenal ulceration	168	19.8
Systemic causes	52	6.2
Neoplasms	37	4.3
Miscellaneous-reflex intestinal, appendix, amebiasis, ulcerative colitis, etc.	171	20.0

[1]Based on objective evidence.

From the Departments of Medicine and Surgery, Northwestern University Medical School and St. Luke's Hospital, Chicago.

TABLE II.—RESULTS OF BILIARY TRACT SURGERY—1823 CASES

Reported by	Year	Cases	Diagnosis	Results	
				Satisfactory	Unsatisfactory
Davis (11)	1928	144	Mixed[1]	90.9%	9.1%
Catell (10)	1929	624	Mixed	67.8%	32.2%
Stanton (13)	1932	90	Stoneless	53.0%	37.0%
Judd and Priestley (32)	1932	72	Stoneless	82.5%	17.5%
Judd and Priestley (32)	1932	534	With stones	76.2%	23.8%
Goldish and Gillespie (21)	1933	296	Mixed	62.8%	37.2%
Howard (26) and Brown (8)	1934	63	Mixed	44.4%	55.6%

[1]Mixed—designates both stone and non-stone cases.

A study of various published statistics concerning the surgical treatment of gall-bladder disease suggests that surgery alone has proved inadequate in a considerable portion of the cases. A more prolonged period of observation with a more careful selection of the cases requiring surgery, combined with a better understanding of the proper medical management of biliary tract disease would greatly reduce the number of surgical failures. In many instances intelligent postoperative medical management is necessary to complete the cure. Failure to develop a satisfactory medical management of many gall-bladder conditions has thrown all these cases into the realm of surgery.

It is difficult, however, to evaluate the results of surgery as reported in the literature upon an equitable basis due to the different criteria of improvement used by the various authors. Some of the investigators have arbitrarily differentiated between complete and relative cures and improvement. In compiling Table II, results were considered only as satisfactory or unsatisfactory. Cases designated in the literature as improved only and not even relatively cured have been classed as unsatisfactory in this tabulation.

It is significant that the more conservative the criteria of improvement and the longer the duration of the postoperative periods of observation, the less effective were the results of surgery. In Stanton's series of 90 stoneless cases followed for an average of 3.5 years after operation, no relief was obtained by 47.0 per cent of the patients. Following patients postoperatively over long periods of time and using similar rigid standards of cure, Howard and Brown found that 20.6 per cent of the 55.6 per cent of the patients designated as unsatisfactory in the table obtained no relief whatsoever from surgery in their cases.

The available data indicate quite definitely that approximately one-third of all patients subjected to biliary tract surgery show little or no improvement after operation. Two distinct conclusions become evident: first, there is a definite need for a more careful selection of cases for operation; second, adequate medical management is a problem of paramount importance. Apparently the best subjective results are obtained in patients subjected to surgery who give histories of repeated colic, common duct stone, or chronic pancreatitis; poorest results obtained in patients in whom cholecystitis existed without cholelithiasis.

We believe that there are several fundamental conditions which require consideration in the medical and surgical management of a diseased gall bladder. These are: (1) stasis in the biliary tract; (2) infection of the gall bladder; (3) the varying degrees of hepatitis and liver damage accompanying the changes in the gall bladder; (4) pericholecystitis with adhesions to adjacent viscera; (5) accompanying pancreatitis, the result of stasis, or blocking at the sphincter of Oddi. The exact rôle of each factor in the production of the characteristic syndrome of gall-bladder disease is not definite and varies in the individual patient.

As early as 1892 Naunyn postulated his well known stasis infection conception of the etiology of gall stones. Since that time numerous workers have emphasized bile stasis as one of the critical phenomena associated with the pathological gall bladder. Elimination of bile stasis or palliation thereof was the basis for Lyon's duodenal drainage therapy. Many modifications of his original technique (34, 35) have been suggested. Although some few clinicians still employ duodenal drainage, the results in general are too inconstant to warrant widespread usage.

A great many cholagogic preparations have been used in the past in order to stimulate bile

flow. Magnesium sulphate has been employed as a cholagogue for many years because of its action in relaxing the sphincter of Oddi. It is difficult, however, to correlate the rationale of the popular low fat, low cholesterol dietary and magnesium sulphate therapy. If stasis is to be overcome, then the most physiological method of inducing evacuation of the gall bladder—the presence of fat in the duodenum—is totally disregarded. A low fat diet places the gall bladder at rest, whereas magnesium sulphate achieves a directly antagonistic action. We fail to see the logic in abandoning a physiological method of inducing gall-bladder emptying and substituting an artificial mechanism. Furthermore, according to Ivy (27), the consensus is that magnesium sulphate is not as effective as egg yolk and cream or as olive oil and oleic acid.

Although a large percentage of patients with diseased gall bladders are chronically constipated and magnesium sulphate does have a cathartic action, the end-result of its continued use is generally the development of a highly irritable bowel with accompanying reflex pylorospasm to add to the original complaints referable to the gall bladder. When this latter syndrome is produced in a patient with hyperactive visceral reflexes, the production of a gall-bladder dyskinesia often follows.

The second inconsistency in this form of gall-bladder management is the limitation of foods high in cholesterol. We have been unable to find any conclusive evidence that there is any hypercholesteremia in patients with cholelithiasis. Whitaker, quoting Fowweather and Collinson, states that hypercholesteremia is the most significant aberration of the blood in cholelithiasis, a relation between the two conditions having been often observed in patients. Andrews (15) in a series of 250 patients with gall stones made studies of the blood levels of cholesterol and found no correlation. Campbell has likewise shown that the average patient with gall stones has a normal level of blood cholesterol. In recent months we have run blood cholesterol determinations routinely on patients under our observation for gall-bladder disease. Elevations of the blood cholesterol have been found only in those patients who have a clinically demonstrable hypothyroidism or who have or just have had obstructive jaundice.

Whitaker has also attached undue significance to the experimental feeding of diets high in cholesterol to laboratory animals. Quoting Hansen and Dewey, he states that overfeeding with lipids, or intraperitoneal injections of cholesterol emulsions, can produce an increase of cholesterol in the blood as well as masses resembling gall stones in the bile. Studies by Fox, Gardner and Gainsborough, McMaster and Elman, Andrews and Dostal (1), Jones, and others do not support these findings, and on the contrary definitely indicate that cholesterol in the diet has no relation to either the blood or bile levels. Further studies by Andrews in humans show that there is no correlation.

The factors of primary infection and reinfection in producing the pathological gall-bladder have long formed the basis of treatment in many proposed forms of managements. Salicylates, hexamines, and other substances have been employed, as gall-bladder "disinfectants." Besides the irritating effect of these substances, especially the salicylates, upon the stomach outlet, it does not appear that infection plays an especially significant part. From their investigations of gall bladders removed at operation, Andrews and Henry (2) conclude that infection is only a secondary factor, mechanical factors being primary. Similar observations with conclusions that cultures of bile or tissue from different portions of the biliary tract are sterile in a considerable proportion of cases have been reported by Rehfuss and Nelson (40), Hanssen and Yurevich, and others. In this connection, one of us (H. E. M.) has cultured all bile drained from gall bladders at operation and in 50 consecutive cases was unable to obtain growth of pathogenic organisms.

In addition to the problems of stasis and infection, the third problem with which adequate medical management must cope is the liver damage associated with the pathological changes in the gall bladder. In 1918 Graham (22) reported varying degrees of hepatitis constantly present with cholecystitis. Numerous subsequent workers have reported

similar findings. Flint in 1930 reported a series of 34 cases in which both gross and microscopic studies from biopsy specimens removed at operation demonstrated hepatitis associated with cholecystitis in the majority of cases. Levulose tolerance tests run on the same patients closely agreed with the microscopic evidence of liver damage. T. R. Brown (8) has stated that there is good evidence that certain of chronic gall-bladder cases in reality present symptoms far more referable to a diseased liver and biliary tract than to the gall bladder alone.

Many consider the existence of a hepatitis to be a definite surgical indication regardless of the severity of the gall-bladder complaints. They point out the fact that were the gall bladder not removed, the hepatitis would be aggravated. Even if hepatitis has not become evident by means of laboratory and clinical studies they state that the gall bladder should be removed before liver damage does occur. Such concepts are well founded if stasis cannot be alleviated by medical management and bile is permitted to stagnate in the biliary tree. Stasis frequently affects the pancreas as well as the liver, leading to subacute or chronic pancreatitis. This condition yields best to a prolonged drainage and, when present, contra-indicates removal of the gall bladder, in the opinion of many authorities. It should be remembered, however, that the liver and pancreas have remarkable regenerative powers, and if stagnation of bile can be prevented medically, one of the important indications for surgical intervention can be eliminated. Furthermore, it is well established that removal of the gall bladder is followed by compensatory dilatation of the entire biliary duct system due to disturbances of the pressure regulatory mechanism of the biliary tract. It is questionable whether such a reaction favors alleviation of an existent hepatitis. In this connection, Kohlstaedt and Helmer studied the hippuric acid excretion as a test of liver function, employing the method described by Quick in 1933, in a series of 22 cases of extrahepatic biliary tract disease which were subjected to surgery. The results of the test varied widely. In 3 cases tests were made after the patients had completely recovered from the surgical procedure. The hepatic function, which had been lowered pre-operatively, did not return to normal in any of these cases.

In a previous paper (6) we reported the results of treatment of 65 cases of chronic cholecystitis, both with and without calculi, by various methods of medical management. Patients under observation were followed at 30 day intervals with cholecystographic examination. Our findings definitely indicated that patients can be managed medically so as to become relatively symptom free and ultimately have a roentgenologically normal gall bladder in many cases. While gall bladders with calculi did not show the roentgen improvement that the stoneless gall bladders did, the subjective improvement was consistent. Best results both subjectively and objectively from roentgenologic studies were obtained by simultaneously administering: (1) ketocholanic acids[1] to stimulate the flow of hepatic bile; (2) hourly feedings of milk and cream to induce contraction and emptying of the gall bladder at frequent intervals; (3) antispasmodic medication (tincture of belladonna m. viii, elixir of phenobarbital grs. ½, t.i.d.) to diminish the irritability of the gastro-intestinal tract, thereby alleviating stasis due to hypertonicity. In severe cases bed rest was necessary at the time this form of management was started.

In a subsequent study (7) the results of the treatment of an additional group of 55 cases of chronic gall-bladder disease showed that a large percentage of patients were able to obtain relief upon this form of medical management.

The choice of ketocholanic acids for the purpose of stimulating the secretion of bile was based upon experimental studies upon laboratory animals (37). Our studies, carried out in collaboration with Dr. K. K. Jones, indicated that greater choleresis with less toxic manifestations could be obtained using this preparation of bile acids.

Although our observations clearly demonstrate the efficacy of medical management based upon sound physiological principles, there should be no misconception that we are

[1]Ketochol, supplied to us by the G. D. Searle and Company, Chicago.

minimizing the place of surgical treatment. The point which we wish to emphasize is that there should be a definite revision of ideas as to just what constitutes adequate medical management and what are surgical indications.

Before discussing the surgical aspects of the problem there are certain general considerations which must be kept in mind. In the first place, the clinician attempting medical management must know that procrastination in the face of well defined surgical indications is not without hazard. As Ivy (28) has pointed out, the older a patient becomes, the higher the mortality in biliary tract operations. The second point to be kept in mind is that in the presence of multiple small stones, the sudden impaction of a calculus in the common duct is an omnipresent danger. Rehfuss and Nelson (41), in an analysis of a large number of cases, found that approximately 30 per cent of all patients with cholelithiasis present symptoms of obstruction at some time. Further studies by Judd and Marshall (31), however, indicate that complete obstruction occurs in a relatively small proportion of cases of common duct stones. In their series of 1,608 patients with common duct stone, 27 per cent had not been icteric.

Some authors have stressed the fact that primary carcinoma of the gall bladder or biliary tract has a higher incidence in patients with cholelithiasis. Vincent has recently stated that at least 70 per cent of the cases of malignant disease of the gall bladder and common duct occur in association with stones. In a series of 9,550 gall bladders removed surgically at the Mayo Clinic, Wellbrock reports the finding of 69 adenomas. Of this number, however, only 38 were associated with stones and only 2 were malignant, 1 of the latter occurring in a non-calculous gall bladder.

In the absence of other indications, there are 3 groups of gall-bladder disease which we believe will respond to physiological medical management: (1) The gall-bladder dyskinesias; (2) chronic cholecystitis where no calculi are present; (3) chronic cholecystitis with large soft calculi, few in number, and with which the patients have no, or very infrequent, colic-like attacks. Even in this latter group we have found that a large number of patients become relatively symptom free when treated by the methods we have described (6, 7). Such patients, however, who do not respond to a reasonable trial period of such therapy should receive surgical treatment without further delay.

As with most surgical conditions, the clinician is usually confronted with a perplexing problem when the patient either flatly refuses operation or is such a poor surgical risk that medical management is required. Such patients are not few, and we have found that the program of management as herein outlined is the most satisfactory form of palliative treatment.

WHAT ARE THE INDICATIONS FOR OPERATION IN GALL-BLADDER DISEASE?

Enumerated in their order of frequency with our opinion concerning *when* to operate, the following are definite indications:

1. *Cholelithiasis giving definite gall-stone colic.* As a rule it is advisable to permit the attack to subside or abate before operating. There are cases, however, in which the severe pain persists, the icterus increases, and the patient's condition is growing worse. In this type of acute gall bladder, early operation is preferable.

2. *Empyema of the gall bladder.* In the acute cases in which the patient has chills and fever and is definitely growing worse, immediate operation is indicated.

3. *Obstructed cystic duct with a markedly dilated gall bladder.* Such a gall bladder is often filled with white bile. Infection may develop. At times it becomes difficult to distinguish between empyema and white bile. In some cases the gall bladder may be so stained and distended with thick dark bile that it resembles a gangrenous gall bladder. In other instances the gall bladder may rupture. The condition is definitely surgical and should be operated upon when diagnosed.

4. *Obstructive jaundice.* This condition is due as a rule to a common duct stone, stricture of the common duct, or to extrabiliary tract inflammation with compression of the duct, either from a subacute or chronic pancrea-

titis or from an extrabiliary or intrabiliary tumor. Such patients should be observed carefully and be subjected to operation when the obstructive jaundice is lessening or has subsided. Even these patients, however, occasionally have to be operated upon during the acute jaundiced stage to save the patient's life.

5. *Subacute or chronic pancreatitis, usually accompanying a cholecystitis.* As a general rule such patients should be placed upon careful medical management. Operation is indicated if the symptoms fail to subside after a few weeks or if the condition is definitely growing worse. In 3 cases which one of us (H. E. M.) had, the attacks were very acute, the jaundice very marked, and the patients grew progressively worse. All 3 patients were operated upon from the second to the seventh day. In each case the gall bladder was distended and the pancreas definitely enlarged. In 1 case the swollen pancreas simulated a tumor the size of a baseball. Prolonged drainage of the gall bladder was the operative procedure in all cases. All 3 recovered.

6. *Cholecystitis.* In most instances when this diagnosis is made the patient is definitely a medical rather than a surgical problem. The majority will readily improve on careful medical management. When no improvement occurs after persistent effort, surgery is justified. Usually a careful investigation of the pancreas at the time of operation will reveal changes typical of chronic pancreatitis.

7. *Gangrenous gall bladder.* This is presumably a rare condition, but according to Bailey, of St. Louis, is more common than the profession realizes. It usually results from recurring attacks of cholelithiasis colic, with accompanying gall-bladder inflammation and fibrosis, and this combined with gall-stone pressure at the neck of the bladder so interferes with the circulation that an area of necrosis develops. The gangrene may be of only a small portion of the wall or may extend to include most of the organ. Rupture is not infrequent. The mortality rate is very high, especially in the older patients. It is seldom diagnosed except at operation. The threat of this condition developing is a strong argument in favor of surgery in the presence of recurring attacks of gall-bladder disease, unrelieved by medical management.

The indefinite upper right quadrant syndrome that may mean dysfunction of the biliary tract, pancreas, duodenum, or stomach rarely belongs in the field of surgery. In all of these cases the gall bladder may at times fail to visualize normally. Patients presenting these indefinite complaints should not be subjected to operation without prolonged careful medical management. It should be remembered likewise that there are probably more patients still enjoying comfortable existence with adhesions about the gall bladder or malformations of this organ than have ever been operated upon for such conditions. The majority of such patients are suffering from functional conditions only temporarily relieved by surgery. It is the surgical treatment of such patients that accounts for the high percentage of unsatisfactory surgical results.

WHEN SURGERY IS PERFORMED WHAT IS THE OPERATIVE PROCEDURE RELATIVE TO THE REMOVAL OR DRAINAGE OF THE GALL BLADDER?

It is almost unorthodox for a surgeon to express even a favorable opinion concerning cholecystostomy. In our opinion, however, there are very definite physiological indications for this procedure. We concur with Ivy's view that the gall bladder that concentrates should not be removed except for very definite indications.

It has been stated by several authors in the past that the drained gall bladder never gives a normal response upon roentgenologic examination. This has been one of the strong arguments in favor of the total removal of all gall bladders. It has swung the majority of surgeons to the "-ectomy" as against the "-ostomy" side of gall-bladder surgery. In 1927 Spurling and Whitaker examined the gall bladders of 12 patients by the Graham-Cole test after they had been subjected to surgical drainage. They found that none of the gall bladders visualized. Moore (23) in 1928 confirmed the findings of these authors. One of us (H. E. M.) was unable to substantiate these findings. Ten patients upon whom cholecystostomies had previously been

performed were studied roentgenologically from 1 to 10 years after operation. Six of the 10 patients showed a normal response to the Graham-Cole test and 8 of them were free from symptoms.

It was further observed by several of the internists on the St. Luke's staff that poor results were being obtained in the patients subjected to routine cholecystectomy. Further studies were therefore carried on by Jenkinson and Foley in the roentgenologic department. Twenty-eight patients who had been treated by cholecystostomy from 8 months to 20 years previously were subjected to a complete series of cholecystographic examinations. Seven of the patients were males ranging in age from 43 to 78 years. Twenty-one were females between the ages of 32 and 66 years. At the time of operation the gall bladders were drained from 8 days to 4 weeks. *Nineteen of these patients gave a dye response that demonstrated a gall bladder which filled and emptied normally and gave a homogeneous shadow. Two gave normally functioning gall bladders with slight defects in contour. Seven were definitely pathological.* Twenty-one or approximately 70 per cent of these patients previously subjected to surgical drainage gave a normal response.

Additional studies (H. E. M.) on private patients previously cholecystostomized showed that 68 per cent of a total of 40 patients gave a normal gall-bladder visualization. These two groups of cases show that gall bladders which have been subjected to surgical drainage can be objectively demonstrated to be capable of carrying on normal function. We definitely believe, therefore, that it is not unorthodox to endeavor to preserve the normal physiological activity of the gall bladder and biliary tract whenever possible.

In our opinion cholecystostomy is indicated:

1. Whenever, after exposing the gall bladder and carefully examining the liver and the pancreas, one finds a definite condition of subacute or chronic pancreatitis is present, with or without cholecystitis or stones, provided the gall bladder is not so diseased that it must be removed.

It is the experience of one of us (H. E. M.) and confirmed by the writings of Archibald, de Tarnowsky, and others, that when the gall bladder is drained because of an existing chronic pancreatitis, prolonged drainage for 6 to 12 weeks is preferable to the usual few days to 2 weeks. The recurrences and the cases that continue to have upper right quadrant distress most frequently follow a short drainage period. Bile drainage gives the inflammatory changes in the pancreas the best chance for resolution, a condition which usually requires weeks and months.

2. Whenever a few stones, usually cholesterol, are found in a gall bladder which on close inspection is otherwise negative. Because it has become the container of stones is not a sufficient reason for removing the gall bladder. We are convinced that the percentage of cures in this group is just as high, if not higher, than when the gall bladder is removed. Furthermore the operation is simpler.

3. In the presence of acute empyema of the gall bladder, it is our opinion that a quick drainage operation is safer and preferable to the more prolonged cholecystectomy.

When the surgeon exposes the gall bladder and biliary tract expecting to find stones and fails to find any condition indicative of pathological changes, it is far wiser to back out than to remove or even drain such a gall bladder. The day is past when this organ should be considered a useless non-functioning vestigial structure.

Cholecystectomy is definitely indicated when a diseased, distended, stone laden gall bladder is found. In the more severe forms of biliary tract disease, it still is and probably always will be more frequently indicated than is cholecystostomy. It is not our purpose to condemn or belittle this procedure. Rather ours is a plea for a more careful individualization of every case instead of subjecting each patient with gall-bladder disease to a routine cholecystectomy.

CONCLUSIONS

1. We believe that the present conceptions of the medical management of gall-bladder disease using low fat, low cholesterol diets in conjunction with saline purgatives have no sound physiological basis.

2. On the basis of our studies of 120 patients with chronic gall-bladder disease, we have found that the use of hourly feedings of milk and cream to induce contraction and emptying of the gall bladder, ketocholanic acids to stimulate the flow of hepatic bile, and antispasmodic medication to diminish the irritability of the gastro-intestinal tract, effectively relieve symptoms and reduce the incidence of colic in the majority of cases.

3. Statistical data indicate the persistence of morbidity in patients with gall-bladder disease following approximately one-third of all operations upon the biliary tract. In a large number of patients, therefore, an adequate program of medical management would be preferable to surgery.

4. Removal of the gall bladder does not necessarily bring relief to patients with chronic gall-bladder disease, especially if associated with pancreatitis, unless colic and intermittent obstruction has been the predominant clinical picture. In our opinion routine cholecystectomy is an unwarranted procedure and in many cases surgical drainage would be preferable.

5. There should be a definite revision of ideas as to what constitutes adequate medical management and what constitutes indications for surgery in patients with chronic gall-bladder disease.

BIBLIOGRAPHY

1. ANDREWS, E., and DOSTAL, L. E. Arch. Surg., 1933, 26: 267.
2. ANDREWS, E., and HENRY, L. D. Bacteriology of normal and diseased gallbladders. Arch. Int. Med., 1935, 56: 1171.
3. ARCHIBALD, E. W., and KAUFMAN, M. Surgical diseases of the pancreas. In Practice of Surgery by Dean Lewis. Hagerstown, Maryland: W. F. Prior Co., 1932, 7: 43.
4. BAILEY, FRED W. Gangrene of the gall bladder. Delivered before meeting of Chicago Surgical Society, May 7, 1937.
5. BLADEFORD, J. M., and DROGER, M. F. Gastric symptoms with particular reference to gall-bladder disease. J. Am. M. Ass., 1924, 83: 412.
6. BROWN, C. F. G., and DOLKART, R. E. Ketocholanic acids in the medical management of low grade gall-bladder disease. J. Am. M. Ass., 1937, 108: 458.
7. Idem. The medical management of low grade gall-bladder disease. Meeting of Central Society for Clinical Research, Chicago, Nov. 6, 1936.
8. BROWN, T. R. The results of treatment, medical and surgical in gallbladder disease from a clinician's point of view. Am. J. Digest. Dis., 1934, 1: 221.
9. CAMPBELL, J. M. H. Cholesterol in blood in cases of gallstones. Quart. J. Med., 1924, 18: 123.
10. CATELL, R. B. End results of surgery of the biliary tract. Ann. Surg., 1929, 89: 930.
11. DAVIS, B. B. Operative mortality and end results in gallbladder surgery. Ann. Surg., 1928, 87: 735.
12. DAVIS, T. D., and VANDER HOOF, D. A study of the causes of indigestion based on an analysis of 4,000 consecutive cases. Virginia M. Month., 1926, 53: 446.
13. DE TARNOWSKY, GEORGE, and SARMA, P. J. Surgical treatment of chronic pancreatitis. Ann. Surg., 1935, 101: 1342.
14. DEWEY, K. Experimental hypercholesteremia. Arch. Int. Med., 1916, 17: 757.
15. DOSTAL, L. E., and ANDREWS, E. Etiology of gallstones. III. Effect of diet on the bile salt-cholesterol ratio. Arch. Surg., 1933, 26: 258.
16. FLINT, E. R. The association between gall bladder lesions and hepatitis in the human subject. Brit. M. J., 1936, 1: 1041.
17. FOSTER, N. B. The Examination of Patients. Philadelphia: W. B. Saunders & Co., 1923, p. 117.
18. FOX, F. W. The composition of human bile and its bearing upon sterol metabolism. Quart. J. Med., 1927, 21: 107.
19. FOWWEATHER, F. S., and COLLINSON, G. A. Certain chemical changes associated with gallstones with special reference to the relation between gallstones and hypercholesterolemia. Brit. J. Surg., 1927, 14: 583.
20. GARDNER, J. A., and GAINSBOROUGH, H. Blood cholesterol studies in biliary and hepatic diseases. Quart. J. Med., 1930, 23: 465.
21. GOLDISH, D. R., and GILLESPIE, M. G. Review of 347 gallbladder operations. Am. J. Surg., 1933, 21: 30.
22. GRAHAM, E. A. Hepatitis—a constant accompaniment of cholecystitis. Surg., Gynec. & Obst., 1918, 26: 394.
23. GRAHAM, E. A., COLE, W. H., COPHER, G. H., and MOORE, S. Diseases of the Gall Bladder and Bile Ducts. Philadelphia: Lea & Febiger, 1928.
24. HANSEN, S. Die Bedeutung des Cholesterins fur die Bildung von Gallensteinen durch experimentalle Untersuchungen beleuchtet. Acta chirurg. Scand., 1927, 62: 483.
25. HANSSEN, E. C., and YUREVICH, A. Bacteriologic observations in disease of the biliary tract: a comparison of the operative findings with those of non-surgical drainage of the biliary tract in 104 cases. Am. J. Digest. Dis., 1935, 2: 460.
26. HOWARD, J. T. Results of biliary tract surgery. Am. J. Digest. Dis., 1934, 1: 270.
27. IVY, A. C. The physiology of the gallbladder. Physiol. Rev., 1934, 14: 47.
28. Idem. The etiology and therapy of biliary tract disease from the viewpoint of applied physiology. Ohio State M. J., 1936, 32: 1185.
29. JENKINSON, E. L., and FOLEY, J. M. Cholecystographic findings following cholecystostomy. Am. J. Roentgenol., 1936, 36: 301.
30. JONES, K. K. Unpublished work. Personal communication to the authors.
31. JUDD, E. S., and MARSHALL, J. M. Gallstones in the common bile duct. Arch. Surg., 1931, 23: 175.
32. JUDD, E. S., and PRIESTLEY, J. T. Ultimate results from operations on the biliary tract. J. Am. M. Ass., 1932, 99: 887.
33. KOHLSTAEDT, K. G., and HELMER, O. M. A study of

the hippuric acid excretion as a test of liver function. Am. J. Digest. Dis., 1936, 3: 459.
34. LYON, B. B. V. Choledochitis, cholecystitis and cholelithiasis, need of early diagnosis and treatment. New York M. J., 1920, 112: 23; 56.
35. Idem. Non-Surgical Drainage of the Gall Tract. Philadelphia: Lea & Febiger, 1923.
36. MCMASTER, P. D., and ELMAN, R. Studies on urobilin physiology and pathology: II. Relation of bile to the presence of urobilin in the body. J. Exper. Med., 1929, 41: 513.
37. MOCK, H. E., BROWN, C. F. G., and DOLKART, R. E. Unpublished data.
38. NAUNYN. Klinik der Cholelithiasis. Leipzig: F. C. W. Vogel, 1892. English Translation by Garrod, London, The New Sydenham Society, 1898.
39. QUICK, A. J. Synthesis of hippuric acid: new test of liver function. Am. J. M. Sc., 1933, 185: 630.
40. REHFUSS, M. E., and NELSON, G. M. The problem of infection in gall-bladder disease with a report on the experimental production of cholecystitis. Am. J. Digest. Dis., 1935, 1: 759.
41. Idem. Medical Treatment of Gallbladder Disease. Philadelphia: W. B. Saunders & Co., 1935, p. 394.
42. SPURLING, R. G., and WHITAKER, L. R. End results of cholecystostomy as shown by cholecystogram. Surg., Gynec. & Obst., 1927, 44: 463.
43. STANTON, E. MACD. The stoneless gall-bladder. Am. J. Surg., 1932, 18: 246.
44. VINCENT, B. Discussion of case records of Massachusetts General Hospital. New England J. Med., 1937, 216: 251.
45. WELLBROCK, W. L. A. Adenoma of the gallbladder. Am. J. Surg., 1934, 23: 358.
46. WHITAKER, L. R. The relation of biliary dysfunction to lithiasis. New York State J. M., 1934, 34: 1.

CLINICAL SURGERY

FROM THE SERVICE OF HAROLD BRUNN, MOUNT ZION HOSPITAL

THE INTERPOSITION OPERATION WITH STERILIZATION

FRANKLIN I. HARRIS, M.D., F.A.C.S., San Francisco, California

THE revival of interest and excellent results reported recently in the treatment of cystocele and prolapse by the operation of interposition has prompted the writer to offer a detailed account of the modern technique of this procedure, originally described by Watkins and Wertheim. This valuable operation early fell into disrepute because of unjustified criticisms.

The occurrence of pregnancy occasionally in an interposed uterus in which the operator had failed to take proper precautions against such a complication was publicized as a condemnation of this operation. The appearance of an elongated hypertrophied cervix through the introitus following interposition was charged as a failure to cure prolapse, whereas the failure was chargeable to the operator for not recognizing the necessity of combining cervical amputation with interposition in such a case. The attempt to perform this procedure in small, contracted vaginas led to technical difficulties and disappointment in the method. Today, the sound basic principles enunciated by Watkins and Wertheim are receiving the recognition they so justly deserve by surgeons who have followed the proper indications and carefully developed a safe and simple technique in applying these principles in the treatment of cystocele and prolapse.

Cattell and Swinton report satisfactory results from the Lahey Clinic. Houston Everett, reporting from Johns Hopkins Hospital, finds this method safer and more satisfactory than vaginal hysterectomy, and Phaneuf finds it to be a very satisfactory method of treating uterovaginal prolapse in a series of 188 cases.

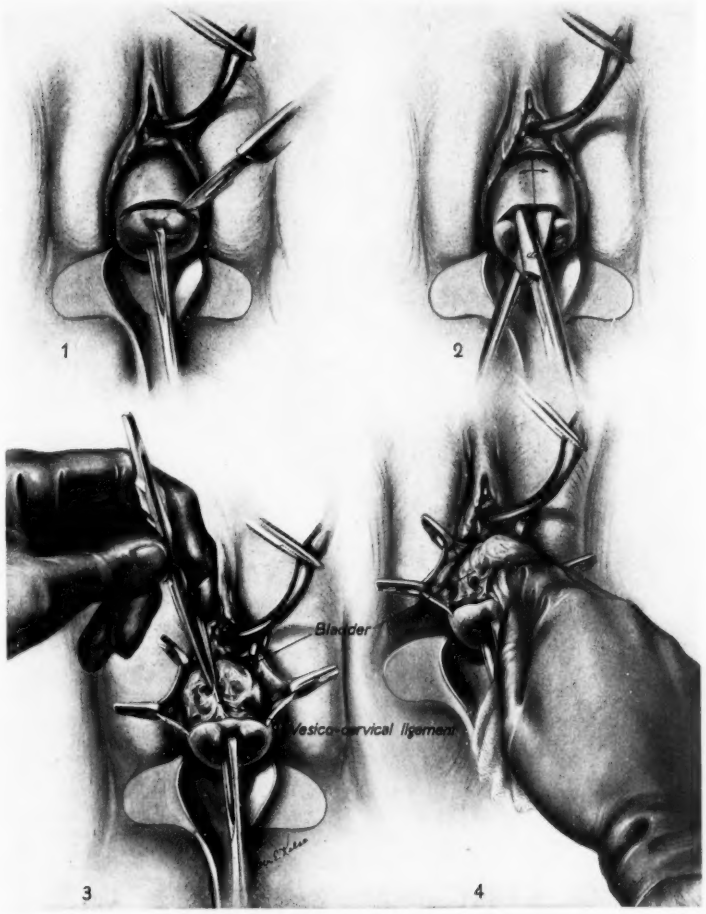
During the past 15 years this procedure has been used at the Mount Zion Hospital, San Francisco, in a series of 57 private and service patients who have been available for satisfactory follow-up examinations from 2 to 7 years following the operation. The results have been highly satisfactory, both from the functional and anatomical viewpoint. There have been no operative deaths in this series and but one recurrence. Eighteen of these patients have been in the childbearing age, most of them in the early thirties, and were sterilized according to the technique herein described. No pregnancies occurred subsequently. Contrary to the opinion expressed by many writers, I do not believe that this procedure should be reserved for only those women at or past the menopause. Young women with large families can by this method be conveniently sterilized without the necessity of abdominal section.

The indication for this procedure has been the presence of a large cystocele, with or without a moderate degree of prolapse, in patients whose uterus was not otherwise diseased or unduly enlarged. In complete prolapse, or in prolapse associated with a diseased uterus, vaginal hysterectomy has been preferred. Chaffin, who performs this procedure in all cases of cystocele as well as first and second degrees of uterine prolapse, emphasizes the contra-indication of previous pelvic laparotomy. When such laparotomy has been done for ligament shortening or pelvic inflammatory disease, adhesions may prevent the delivery of the uterus necessary for successful interposition.

Subarachnoid anesthesia has been used in the majority of these cases. If general anesthesia is used, either cyclopropane or nitrous oxide is the anesthetic of choice.

TECHNIQUE

Step 1 (*Fig. 1*). After the usual vaginal preparation a mushroom retention catheter is placed in the bladder and clamped. It is attached to a towel on the patient's abdomen, where it remains throughout the entire operation. This serves as a later guide to identification of the urethra. A heavy weighted vaginal speculum is inserted to hold the posterior vaginal wall toward the sacrum. The cervix is grasped with a strong tenaculum and turned downward exposing the cystocele and completely inverting the anterior wall of the vagina which is maintained in this position by moderate tension on the tenaculum. A transverse incision of approximately 2 centimeters is made through the mucous membrane of the anterior vaginal wall



Figs. 1 to 16 show the various steps in the operative procedure.

about 1 centimeter above the anterior cervical lip. This incision is carried through the mucous membrane and the closely underlying and adherent fascia down to hard cervical tissue. There is no danger of injury to the bladder at this point as it never descends this low on the cervix even in the most extensive cystocele. If the cervix is badly lacerated or markedly hypertrophied or elongated a trachelorrhaphy or circular amputation should be performed before undertaking the next step of this procedure.

Step 2 (*Fig. 2*). At the completion of such an operative procedure on the cervix, the upper cut edge of the vaginal mucous membrane is held with tooth forceps and a blunt pointed dissecting scissors is gently inserted to separate the bladder from the overlying fascia attached to the anterior vaginal wall. This maneuver is easily accomplished by spreading the blades of the dissecting scissors, the blunt point being inserted well up to within 1 centimeter of the level of the urethra. The dotted line indicates the next incision, which divides the anterior vaginal wall and fascia up to a centimeter of the urinary meatus.

Step 3 (*Fig. 3*). This median longitudinal incision through the vaginal wall and fascia is accomplished with very little bleeding and no danger to the bladder, which in this line of cleavage is very

loosely attached. Difficulty will be encountered if an attempt is made to develop a line of dissection between the fascia and the anterior vaginal wall. Such a step is not necessary and the separation of the two layers off the bladder by the method described is simple, safe, and effective. The Allis clamps are attached to each of the lateral flaps of the vaginal wall and held under moderate tension by the assistants. The bladder is dissected free by sharp and gauze dissection laterally from these flaps down to the cervix. This lateral separation should be carried far enough to permit the excess of vaginal wall to be resected at the completion of the operation. In the midline, just in front of the cervix, there is a fairly firm attachment by strong connective fibers between the bladder and the cervix. These fibers are called the vesicocervical or uterovesical ligament and must be divided with scissors before the bladder can be rolled off the cervix. They are held up by forceps and can be seen to be different from the bladder wall. There is danger at this point of cutting into the bladder if these fibers are not properly identified. The indwelling catheter can be used as a guide if there is any doubt as to the identification of the bladder wall from the vesicocervical ligament.

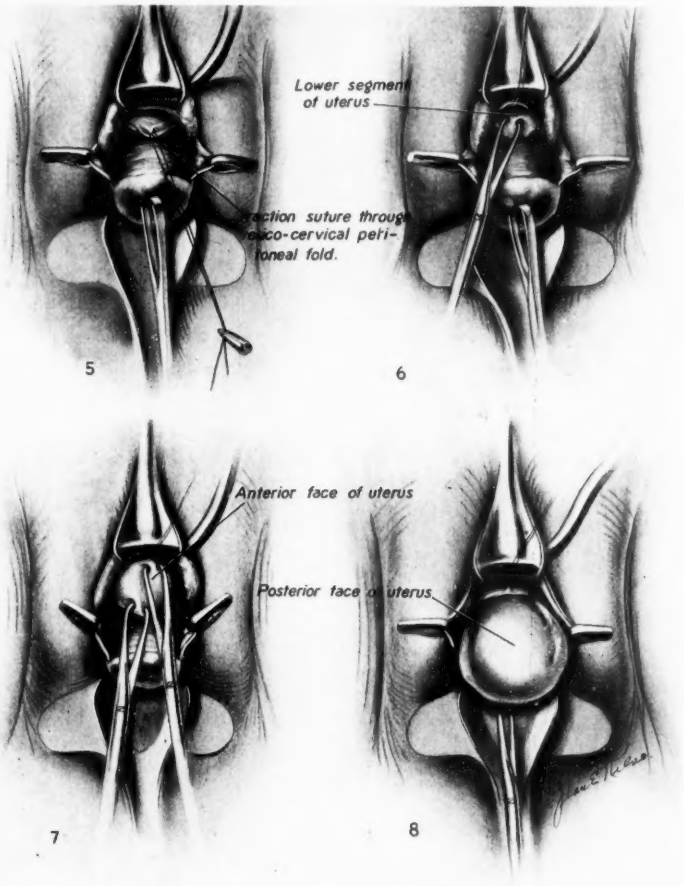
Unless the bladder is completely freed up and rolled off the cervix in this manner so that it can later lie smoothly and evenly on the posterior superior aspect of the uterus, urinary complications might follow the operation. These complications result from sacculation produced in a bladder which is unevenly compressed by the interposed uterus.

Step 4 (*Fig. 4*). If a clean dissection of the bladder from the lateral vaginal wall has been made and the vesicocervical ligament cut, the next important step can be easily accomplished. With a thin layer of gauze covering the gloved finger, the bladder can now be gently rolled up from its descent on to the anterior wall of the cervix. This blunt gauze dissection is carried well upward in order to expose the peritoneum, which at this point is called the vesico-uterine or vesicocervical fold of the peritoneum. Some difficulty may be encountered in this part of the operation if the proper plane of dissection has not been obtained. If sharp dissection has been necessary to free the bladder off the cervix there may be a tendency, in order to avoid cutting into the bladder, to carry the dissection too deep into the cervix. As the dissection is carried higher and higher, it will be entering a false plane lying between the peritoneal pouch and the uterus, and the operator will vainly hunt for the peritoneal fold. Gauze dissection after preliminary sharp dissection of the restraining fibers of the vesicocervical ligament usually establishes the proper plane of cleavage, although in some cases the scissors may be needed to cut some resistant fibers off the bladder wall from the upper part of the cervix. If the operator frequently palpates the indwelling catheter during these steps, there will be little need of seeking a deeper or false line of dissection in an attempt to protect the bladder from injury. The blunt dissection described usually follows the line of least resistance and clearly exposes the peritoneal pouch between the bladder wall and the vesical peritoneum.

Step 5 (*Fig. 5*). A narrow retractor is now placed anteriorly to hold the freed up bladder toward the symphysis and to expose the peritoneal fold. This fold may often be identified by direct vision in this manner and must always be recognized by touch. If the finger presses on this fold toward the uterus and is moved back and forth, the two smooth peritoneal surfaces can be distinctly felt moving on each other. A traction suture of No. 1 plain catgut is now placed through the anterior part of the peritoneal wall which is then held up and incised with scissors. As the peritoneum is opened a small amount of peritoneal fluid may escape which may give the operator the impression it is urine and that he has entered the bladder. However, by further exploration with the finger in the opening the smooth fold of the fundus of the uterus can be felt and perhaps some omentum. If the patient is straining, small bowel or omentum may be forced through the peritoneal opening, and it may be necessary to insert a narrow abdominal pad to keep the viscera back. This annoying complication seldom happens if spinal anesthesia is used, and the patient is in moderate Trendelenburg and a fairly high lithotomy position.

Step 6 (*Fig. 6*). The traction suture on the vesical edge of the opened peritoneum is now held anteriorly thus exposing the anterior wall of the lower segment of the uterus. A single hook tenaculum clamps this portion of the uterus and gently draws it forward. Care must be taken not to tear the uterus by rough traction on the tenaculum, as it leads to troublesome bleeding.

Step 7 (*Fig. 7*). As the uterus is drawn forward a second tenaculum is applied at a higher point on the anterior surface of the uterus. Occasionally the uterine wall is so soft that the tenaculum tears out even with slight traction. In such cases a double heavy mattress suture may be placed deep into the uterine wall so as to serve as a traction suture in order to draw the uterus out of the peritoneal cavity.



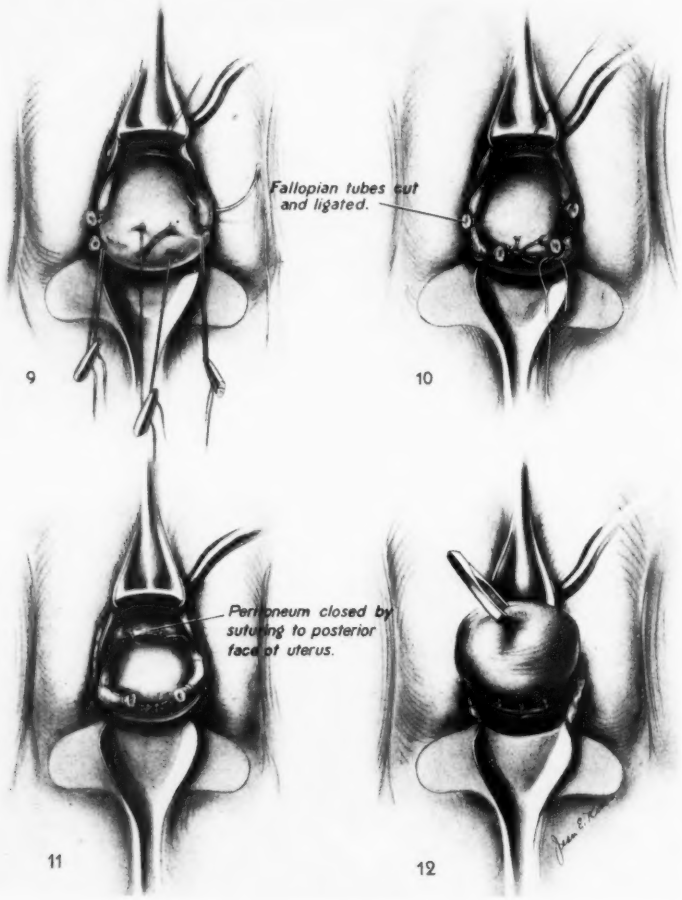
Figs. 5 to 8.

Step 8 (*Fig. 8*). The uterus is now acutely anteflexed and drawn out of the vagina so that only the posterior wall comes into view. The adnexa may now be visualized or palpated. If the patient is in the childbearing age, sterilization must now be performed.

Step 9 (*Fig. 9*). The sterilization procedure is relatively very simple and absolutely dependable in this technique. Ligatures of No. 1 chromic catgut are placed respectively 1 and 1½ centimeters from the cornual insertion of the tubes. The tubes are divided between these two ligatures. In the illustrations is also shown the traction suture which may be used in place of the tenaculum if the uterus is extremely friable.

Step 10 (*Fig. 10*). The principle of sterilization in this technique is dependent on the proximal portion of the tubes being ultimately bound in scar tissue outside of the peritoneal cavity. The two proximal ends of the tubes should be isolated from the distal ends by curving them forward on to the fundus and loosely approximating them to each other in this position.

Step 11 (*Fig. 11*). The uterus is rotated slightly to permit the distal ends of the tubes to drop back into the peritoneal cavity. The traction suture on the vesical edge of the cut peritoneum is utilized again to identify this plica of peritoneum preparatory to closure of the peritoneal cavity. If a narrow abdominal pack has previously been placed

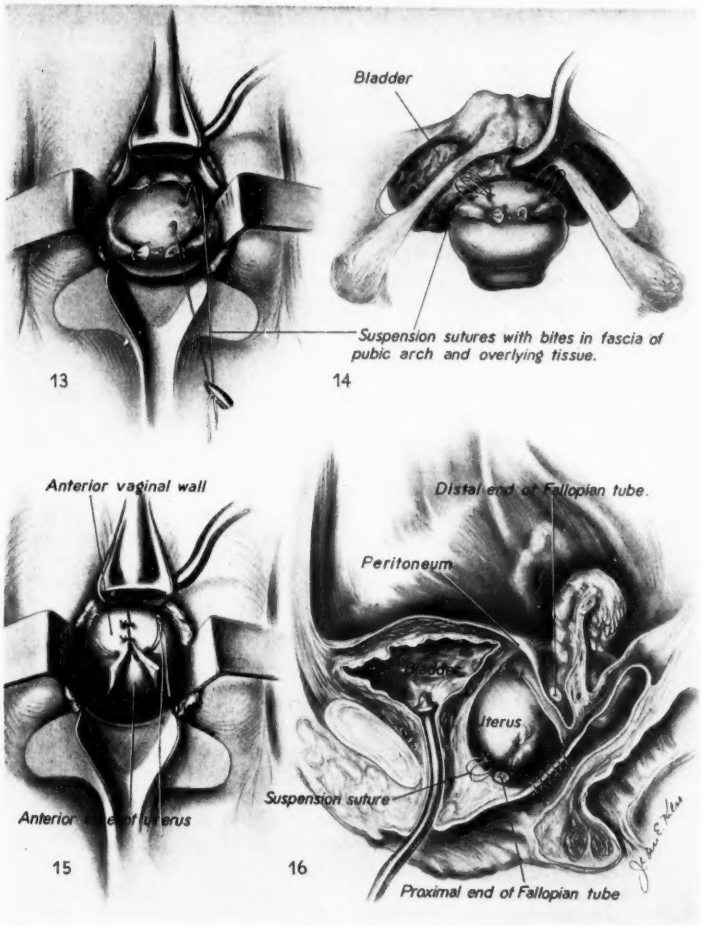


Figs. 9 to 12.

in the peritoneal cavity, it is now removed. The peritoneum is attached to the posterior wall of the body of the uterus by two interrupted catgut sutures, closing the peritoneal cavity, and making the operative area entirely extraperitoneal. In the illustrations the vesical flap appears fixed somewhat too high on the posterior aspect of the uterus. It is important that this suture line be placed low at approximately the level of the junction of the cervix and the body of the uterus.

Step 12 (*Fig. 12*). The fundus of the uterus is rotated toward the peritoneal cavity, thus exposing the anterior wall. It may occasionally be possible easily to demonstrate the cut uterine edge of the peritoneal fold by this maneuver and to suture it with two or three interrupted catgut sutures to the anterior wall. However, this step is not absolutely essential and may be omitted if technically difficult.

Step 13 (*Fig. 13*). In order to fix permanently the fundus of the uterus under the pubic arch so as to act as a shelf for the replaced bladder, Watkins originally described the "crown" suture which passed through the vaginal mucosa from outside, included the fundus of the uterus, and passed out the other side of the vaginal mucosa, the knot finally being tied above the vaginal mucosa after its closure. This suture tends to produce painful swelling and occasional pressure necrosis. In this technique two suspension sutures, similar to the



Figs. 13 to 16.

fixation sutures described by Crossen for suspending the uterus in its new position, are used. They are entirely buried and have proved very satisfactory. I believe they are largely responsible for the absence of recurrences and the firm fixation of the uterus to the pubic edge. No. 3 chromic catgut is used as there may be considerable tension on these sutures. A bite is first taken high up at the angle of the pubic arch, a hemostat first being placed on the short end of the suture. This bite of the needle is into tissues that have a firm attachment to the pubic bone. The needle is passed through these tissues, then carried deep into the fundus of the uterus and back to take a second firm bite into the fascia-like tissue of the pubic arch, and carried by the same hemostat holding the short end of the suture. A similar suture is placed on the other side. If both of these suspension sutures have been satisfactorily placed, the hemostats are removed and, by gentle traction on the two ends of the suspension sutures, the uterus is slowly rotated anteriorly as the anterior bladder retractor is removed. The fundus of the uterus is then placed snugly under the pubic arch exerting some pressure on the urethra. The degree of pressure on the urethra can be estimated before the final step of tying the suspension sutures is completed.

Step 14 (*Fig. 14*). The suspension sutures on either side are tied, thus approximating the fundus of the uterus under the pubic arch and supporting the bladder and urethra. The new position of the urethra with the pressure on it of the uterine fundus is usually sufficient to cure the incontinence associated with the urethrocele found in the majority of cases of cystocele and prolapse. In severe cases of incontinence, a preliminary reefing of the extrinsic urethral muscle is performed as an additional step early in the operation. This is best done after the exposure of the bladder in Step 3 when the torn muscle fibers may be easily identified before the bladder is freed up and reduced into the abdominal cavity.

Step 15 (*Fig. 15*). Closure of the anterior vaginal wall over the uterus completes the operation. If there is an excess of vaginal mucous membrane, excision of this excess on either flap is first performed. The flaps are then approximated in the midline with interrupted No. 2 chromic sutures, each suture taking a bite into the wall of the underlying uterus. Closure is completed by approximating the lower ends of the anterior vagina to the anterior lip of the cervix.

Step 16 (*Fig. 16*). In practically all cases a complete repair of the relaxed pelvic floor is done by one of the standard methods of perineorrhaphy and is essential to a successful result. Sagittal section shows the uterus now acting as a shelf which supports the urethra and bladder. The distal ends of the cut fallopian tubes are within the peritoneal cavity, whereas the proximal portions are entirely extraperitoneal and effectively prevent impregnation.

The immediate postoperative course of the interposition case is extremely satisfactory. There is practically no shock to the procedure and symptoms of abdominal distention are never present. The advantages of this procedure over laparotomy combined with vaginal plastic procedures are seen at once in the smooth convalescence. The patient has been saved the prolonged anesthesia of two separate operative procedures, and pulmonary complications are proportionately lessened. The additional operative risk incident to any laparotomy is removed when the entire procedure can be done through the vagina.

Opponents of the interposition operation have stressed the high incidence of bladder complications, such as dysuria and frequency. As previously pointed out in the technique, such a complication, if permanent, is due to faulty technique in failing to free up the bladder completely so that it can lie smoothly on top of the uterus when the operation is completed. The symptom of urinary incontinence in varying degrees, which practically all of these patients with cystocele and prolapse present, is completely cured by well performed interposition which changes the direction of the urethra and gives the urethral floor the support of the uterine fundus. Reefing of the extrinsic urethral muscles is seldom necessary, although it has been used in those few cases which have shown marked pre-operative incontinence.

The retention catheter remains in the bladder for a period of from 4 to 7 days following the operation. During the first 48 hours it is opened every 6 hours. Following this period the urine is released at 8 hour intervals and the patient is given daily bladder irrigations of 1:30,000 metaphen solution. When the catheter is removed the patient is usually able to void spontaneously. An occasional patient may have symptoms of a residual cystitis which responds to treatment during the first few weeks following surgery.

The average hospital stay of these patients is from 14 to 16 days.

SUMMARY

A description of the technique of the interposition operation based on an experience with 57 cases is given. This procedure has been used with excellent anatomical and functional results in the treatment of cystocele and moderate degrees of prolapse. It has been used in women during the childbearing age with the additional procedure of sterilization and has been found to have less morbidity and mortality than laparotomy combined with vaginal plastic procedures in the treatment of this condition.

REFERENCES

1. Cattell, R. B., and Swinton, N. W. Interposition of the uterus in the treatment of cystocele; the Watkins-Wertheim operation. Surg. Clin. N. America, 1935, 15: 1645.
2. Chaffin, R. C. Procidentia: a new operation for cure of fourth degree prolapse. Am. J. Surg., 1937, 37: 239.
3. Everett, H. End-results with the Watkins interposition operation. Surg., Gynec. & Obst., 1935, 61: 403.
4. Phaneuf, L. E. The surgical management of prolapse of the uterus and vagina. Surg., Gynec. & Obst., 1936, 63: 385.

HALLUX VALGUS

WALTER I. GALLAND, M.D., and HENRY JORDAN, M.D., New York, New York

IN 1904 W. L. Keller in the *New York Medical Journal* published a description of an operative procedure for the correction of hallux valgus. This procedure involved the removal of the proximal articular end of the first phalanx together with the prominence on the internal aspect of the first metatarsal head. At the time of this publication 3 cases were reported with satisfactory results. This operation has been described in American literature from time to time, but has never attained wide popularity.

Abroad during the last 10 or 15 years, there has been a rediscovery of the Keller operation, and it has become particularly associated with the name of Brandes, who has been one of the chief exponents of the method. Altogether about 750 cases have been reported with results so satisfactory that by many authorities this procedure is recommended as the preferential one.

In 1930 Timmer stated that reports of 25 different methods for the operative correction of hallux valgus have been published. This estimate is surely conservative. The great number of methods is indicative of the unsatisfactory state of the operative methods in vogue.

In view of the favorable experience on a larger series of cases abroad of one of the authors (H. J.) with the Keller-Brandes type of procedure, we have determined to evaluate the comparative merits of this operation, for we feel that the results in a small series of cases would warrant recording.

We would first discuss briefly some of the anatomical and pathological aspects of hallux valgus which have a direct bearing upon the operative relief of this condition. Hallux valgus is usually not a congenital but an acquired deformity. Most of these deformities are caused by mechanical conditions which result from a pes plano-valgus transverso-planus. The valgus position of the heel and tarsus is the original deformity in the causative train. The pressure of the foot on the ground while the patient walks causes the abduction of the forefoot and the supination and dorsiflexion of the first metatarsal bone and great toe. The falling of the metatarsal arch is only relative. As a matter of fact the shifting dorsally of the first metatarsal head creates what appears to be a plantar prominence of the second, third, and fourth metatarsal heads. By this mechanism the first metatarsal bone is forced into marked abduction, and this abducted position is not a primary but a secondary deformity. Due to the tension of its tendons, the great toe cannot follow this abduction of the first metatarsus; consequently it deviates and a subluxation of the metatarsophalangeal articulation occurs. Secondary productive arthritis in the first metatarsophalangeal joint may follow.

According to Hohmann a second group exists, in which the metatarsus varus is a part of a varus position of the entire foot. This type of case is decidedly in the minority, and the static group first mentioned most certainly comprises the vast majority of all cases of hallux valgus.

Inasmuch as, according to our conception of hallux valgus, the deformity is initially due to a valgus or plano-valgus, it is obvious that any operative correction can be effective only if the local causative deformity is also corrected. The correction of the entire foot before entering upon the operative phase of the treatment, is of the greatest importance in order eventually to avoid recurrence. We therefore believe that a rigid or spastic flat foot should be manipulated and corrected before an attempt is made to overcome the hallux valgus deformity. Following the hallux valgus operation, the normal position of the entire foot and correct static conditions must be maintained by means of adequate foot plates.

The Keller-Brandes operation is indicated in cases in which the hallux valgus deformity disables the patient and interferes with his work. Patients in this group who desire to be cured radically and rapidly and who wish to return to their work as soon as possible are the proper subjects for this procedure. Those patients who are mainly interested in the immediate cosmetic result of the operation should not be handled according to this method, inasmuch as full control of the great toe is re-established only after a period which must be measured in months.

TECHNIQUE OF OPERATION

The pre-operative preparation of the foot is essential, inasmuch as the skin of this area is grossly contaminated. We would particularly advise that the foot should be closely examined for evidence of fungus infections, and if such are found, a rigid pre-operative treatment should be

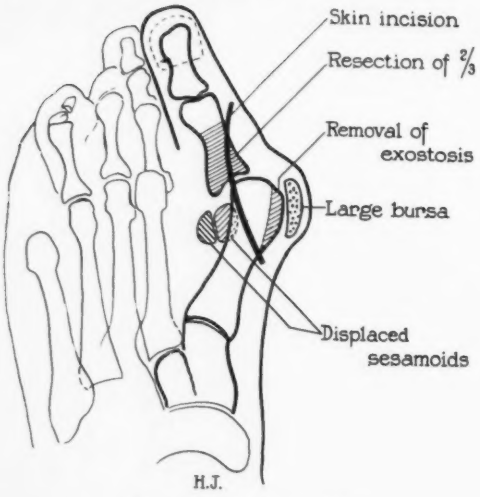


Fig. 1. Operative procedure.

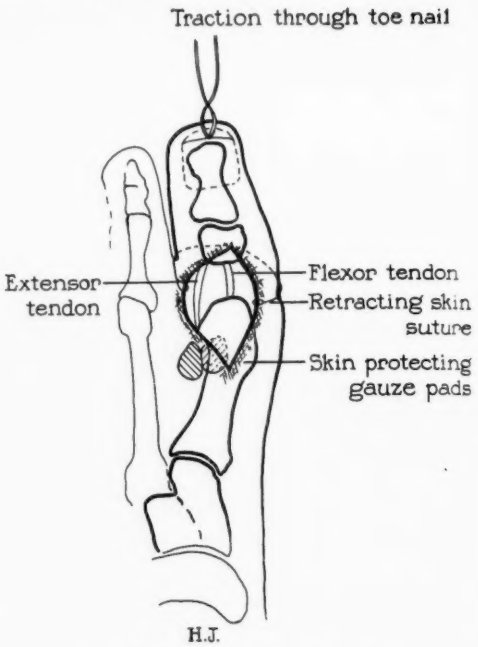


Fig. 2. Appearance before closing.

entered upon until this infection is entirely under control. Even in feet not infected with fungi, it is advisable to provide several days of pre-operative cleansing of the feet in order to remove the abundant contamination which has been ground into the skin in the act of walking.

We prefer to operate on a bloodless field provided by the careful application of an Esmarch bandage. The use of an Esmarch bandage greatly facilitates the operation and saves time. General anesthesia is perhaps somewhat preferable to local anesthesia, as there is no local trauma which might impair the nourishment of the tissues and impede the healing process. Avertin narcosis is often sufficient and, if supplemented with nitrous oxide gas and oxygen, entirely adequate. Of course, if patient prefers, or his general condition does not permit use of general anesthesia, local anesthesia, with ½ to 1 per cent procaine solution with adrenalin, gives satisfactory results.

An incision 2 to 3 inches in length is made on the dorsum of the foot beginning over the distal third of the first metatarsal bone, and curving laterally around the head of the bone to the distal third of the proximal phalanx (Fig. 1). The skin is dissected from the underlying tissues and is retracted so that ample exposure is provided. Instead of using retractors, we have found it most convenient to use retracting sutures which are placed at the lateral and medial skin edges and tied under the plantar aspect of the foot. Before tying these sutures, gauze pads are placed under them at the skin margins. As these sutures are tied, the skin edges are retracted over the gauze pads, and it is no longer necessary to employ an assistant for retraction purposes, and at the same time through the mediation of the gauze pads, the wound is protected from skin contamination. The fascia is now incised longitudinally, and the extensor hallucis tendon is retracted laterally. The prominence of the first metatarsal head is now exposed without removal of the overlying bursa. The capsule of the first metatarsophalangeal articulation is incised transversely, and upon exposure of the articular end of the metatarsal, the groove which separates the exostosis from the head of the first metatarsal bone appears. A chisel is now driven into this groove in the direction of the longitudinal axis of the first metatarsal bone, and the entire exostosis is thus removed. Any osteophytes on the dorsal and lateral aspect of the first metatarsal head are removed, and the entire head of the bone is carefully smoothed. The proximal two-thirds of the proximal phalanx are now exposed by means of blunt dissection with a periosteum elevator. It is well to separate the bone around its entire circumference, particularly on its plantar aspect, in order that the flexor hallucis tendon should not be injured in the sub-

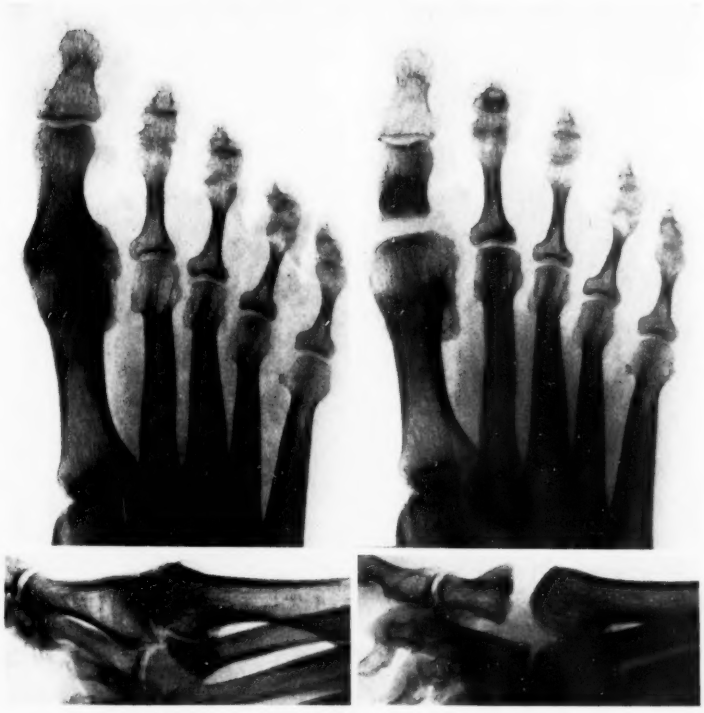


Fig. 3. Left, Case 5, before operation. Right, Case 5, after operation.

sequent osteotomy. The phalanx is now cut transversely with a bone cutting forceps. The section must be made smoothly. It is desirable to remove not less than the proximal two-thirds of the phalanx. The removal of the bone is facilitated by the insertion of a sharp bone hook into the distal end of the proximal fragment to be used as a tractor thus exposing the plantar and internal aspects of the phalanx, so that by cutting with a scissors close to the bone, the fragment can be safely dissected and removed.

The removal of the proximal two-thirds of the proximal phalanx leaves a large wide open wound, in which any potential points of bleeding can be easily recognized and ligated. The fascia which usually at this stage can be found curled back laterally under the extensor tendon is sutured in place by five or six interrupted chromic sutures. A few subcutaneous plain or chromic gut sutures are used, and the skin is closed with absorbable or non-absorbable material, according to the operator's inclination (Fig. 2).

The aspect of the toe immediately after closure is apt to be somewhat disconcerting to the operator performing this procedure for the first time. The digit is hypermobile, and appears simply to hang upon a collar of skin. It is of course easy to bring the toe in perfect alinement with the first metatarsal bone. It is impossible for any tension to exist after this extensive resection. The foot is now immobilized in plaster of Paris with the great toe held in the corrected position. This may be achieved by means of a plaster-of-paris splint applied to the sole of the foot. It is not desirable to remove all of the tension from the extensor and the flexor tendons, and it is equally desirable to avoid skin creases which form due to the relaxed condition of the integument of the toe following the bone resection. In order to avoid undue skin and tendon relaxation and to obtain a good cosmetic result as quickly as possible, it is desirable to keep the great toe in extension or in traction while the foot is immobilized. This may be done be means of a suture through the tip of the great toe, or through its toe nail, and attaching this suture under moderate tension to a post, incor-

Fig. 4. Case 6. Anteroposterior and lateral view of right foot approximately 1 year after operation.

porated in the plaster-of-Paris dressing. The traction should be so arranged as to pull the great toe in a position neutral between abduction and adduction and in slight plantar flexion. Traction can usually be removed at end of a week. For the first few days after the operation, the foot of the patient's bed should be elevated about 8 inches. This adds materially to the postoperative comfort.

As a rule, the postoperative temperature reaction is very slight, and a normal level is achieved 3 or 4 days following the operation. After 5 or 6 days the patient may be out of bed in a wheel chair, and it is possible to discharge patients on whom a unilateral operation has been performed, after 1 week; at this time weight-bearing may be instituted in the plaster. The plaster splint is removed 8 or 10 days following operation, and an elastoplast strapping is applied from the toes to the knee. Particular attention is given to the remodelling of the forefoot in order to restore the metatarsal arch, and the first and fifth metatarsal bones are kept in an adducted position. Plaster casts can be made for the preparation of proper foot braces in about 2 weeks after operation. The elastoplast strapping should be applied for at least 3 weeks. Some physical therapeutic aftercare is desirable, particularly in older patients with poor circulation.

The majority of patients in whom only one foot has been operated upon will be able to return to work about 2 to 3 weeks after operation. Of course, it must be expected that at this time the function will not be even approximately normal. The full benefit of the operation does not become apparent until a period of 6 months has elapsed.

The operative correction of hallux valgus must be considered with the primary view of preserving or restoring with a minimum of risk, the normal physiological mechanism of the foot. Any operative procedure which seriously impairs the function of either the transverse or of the longitudinal arch of the foot is erroneous in its conception. We feel that the Keller-Brandes procedure restores the normal mechanism of the foot with a minimum of risk to the patient.

By effectively removing all deforming tension on the deviated hallux, this operation readily permits the proper alinement of the hallux and of the metatarsus primus varus. There is effective restoration of the contour of the anterior metatarsal arch and the integrity of the longitudinal arch is in no way impaired.

It has been urged that the operation may produce marked metatarsophalangeal arthritis. The risk of this complication is, we think, far less than in any other of the generally accepted procedures, with the possible exception of the major operation. This latter, however, entirely destroys the inner pillar of the anterior and the anterior pillar of the longitudinal arches. If the advice of Brandes is followed and fully two-thirds of the proximal phalanx is removed, a potential joint space of such width is provided as to render subsequent painful articular friction highly improbable.

It has been suggested that the cosmetic result of shortening the great toe is an undesirable feature of the operation. To this criticism we would urge that in the average case of bunion the great toe is unduly long so that the shortening of this digit is, in most cases, entirely desirable. We would also urge that restoration of painless function and not cosmetic considerations should be the prime objective of the bunion operation, and this objective, we believe, is most consistently fulfilled by the Keller-Brandes operation.

A feature of the operation which may be urged, is the factor of safety which is provided in the occasional case in which, despite the most meticulous precautions, the wound becomes infected. The cavity which is left by the removal of the proximal two-thirds of the proximal phalanx is readily drained through the operative incision, and the simple early opening of a few sutures converts the zone of infection into a single, effectively

Fig. 5. Left, Case 7, before operation. Right, Case 7, after operation.

drained pocket. There is no necessity for multiple drainage incisions and the diastasis between the component bones of the articulation again renders the advent of arthritis less probable and absolute ankylosis is certainly not to be anticipated, even after a fairly severe infection.

The operation must also be considered from its applicability to conditions allied with, or frequently complicating, hallux valgus. In those cases in which hallux rigidus is present with or without a valgus position of the great toe, this procedure is spectacular in its efficacy. The complication, sesamoiditis, which so often attends deformations of the forefoot can be effectively coped with during this procedure. The removal of the phalangeal section makes the approach to the sesamoids a simple task and the removal of these ossicles, if desirable, is effected readily.

During the past 2 years 11 of our patients have been operated upon by the Brandes-Keller procedure for hallux valgus or hallux rigidus; in 4 cases on both feet simultaneously, thus giving a total of 15 hallux valgus operations of this type.

CONCLUSION

1. The Keller-Brandes operation for hallux valgus (or rigidus) in which the proximal two-thirds of the proximal phalanx of the great toe, together with any attending exostosis is removed, affords a simple and safe method for coping with all of the deforming influences producing this deformity.

2. The period of postoperative disability is shorter than that of the average exostosectomy.

3. The ultimate cosmetic and functional results are gratifying both to the patient and to the physician.

4. The postoperative morbidity is slight.

REFERENCES

1. Brandes, Max. Zur operativen Therapie des Hallux valgus. Zentralbl. f. Chir., 1929, No. 39.
2. Bugyi, I. Radikaloperation des Hallux valgus. Chirurg., 1935, 7 No. 5: 137.
3. Cleveland, Mather. Arch. Surg., 1927, 14: 1125.
4. Fowler. A Treatise on Surgery, Vol. 2, 622.
5. Kasper. Beitr. z. klin. Chir., 1933, 157: 113.
6. Keller, W. L. New York M. J., 1904, 80: 741–742.
7. Kleinberg, Samuel. The operative care of hallux valgus and bunion. Am. J. Surg., 1936, 15: 75.
8. Lapidus, Paul W. Operative correction of the metatarsus varus primus in hallux valgus. Surg., Gynec. & Obst., 1934, 58: 183.
9. Leuggenhager, K. Hallux valgus. Chirurg., 1935, 7 No. 19: 689.
10. Mayo, Charles H. Ann. Surg., 1908, 48: 300.
11. McBride, Earl D. J. Am. M. Ass., 1935, 105: 1164.
12. Monberg, P. Treatment of hallux rigidus. Acta orthop. Scand., 1935, 6: 239.
13. Peabody, C. W. Surgical care of hallux valgus. J. Bone & Joint Surg., 1931, 13: 273.
14. Petersen, Ferdinand. Zur operativen Behandlung verkruemmter Zehen. Arch. f. klin. Chir., 1888, 37: 678.
15. Silver, David. The operative treatment of hallux valgus. J. Bone & Joint Surg., 1923, 21: 225–232.
16. Singley, J. D. J. Am. M. Ass., 1913, 61: 1871.
17. Stanley, Leo L. et al. Bunions. J. Bone & Joint Surg., 1935, 17: 961.
18. Timmer, H. Die Behandlung des Hallux valgus. Leipzig: Johann Ambrosius Barth, 1930.
19. Truslow, W. Metatarsus primus varus or hallux valgus. J. Bone & Joint Surg., 1925, 7: 98.

INSTRUMENTAL DILATATION OF THE PAPILLA OF VATER

Experimental and Clinical Observations

ROBERT ZOLLINGER, M.D., F.A.C.S., CHARLES D. BRANCH, M.D., and ORVILLE T. BAILEY, M.D., Boston, Massachusetts

THE indications for exploring the common bile duct in operations for cholelithiasis have been fairly well established. Statistics (20) show that calculi are found in the common bile duct in approximately 20 per cent of all cases if exploration of the common bile duct is performed in as much as 40 per cent of such operations. Various methods have been recorded for exploring the common bile duct in order to remove calculi and to determine the patency of the papilla of Vater. In some instances, these steps are followed by dilatation of the papilla. Those who favor this further procedure believe that it promotes the passage of calculi and débris not removed by careful scooping and irrigation of the bile ducts. They feel that a more satisfactory drainage of bile into the duodenum will also be maintained.

It has been our custom to follow the method of Cheever in this operation. This involves the passage into the common bile duct of a No. 10 F. soft woven catheter, which is the size of the average papilla in the human being. Saline is injected through the catheter to establish the patency of the ampulla by the visible filling of the duodenum. The injection of saline is continued while the catheter is slowly withdrawn in order to dislodge and force overlooked calculi into the opening of the common bile duct. Following this, catheters to size No. 16 F. are passed, but rarely those of larger caliber. Allen has recommended the use of Bakĕs metal dilators for extensive dilatation of the papilla of Vater, even up to the size of the common bile duct itself, so as to permit overlooked calculi to escape. Allen and Wallace and Bakĕs have recorded instances of the passage of calculi in the stools following such dilatation. These apparently had been overlooked at the time of operation. We have not encountered any serious complication directly attributable to the catheter method of dilatation of the papilla. However, the possibility and dangers of duodenal reflux have been emphasized (9, 16). Lahey has reported 2 deaths following the use of Bakĕs dilators which he states were the result of overdilatation of the papilla of Vater. All of the various methods of dilatation accomplish the important step of making certain of an unobstructed communication with the duodenum. We have considered whether greater dilatation of the papilla is of sufficient value to the patient to overshadow the dangers associated with extensive stretching of its tissues. In order to study this problem experiments on dogs were carried out to determine both early and late effects of the methods of dilatation on the papilla of Vater. We believe that the anatomic details in this region are sufficiently similar to allow the application of data obtained from dogs to patients. The recent study of Boyden compares this region in man and various animals. In the dog the pancreatic duct and the common bile duct open separately into the duodenum, but there is a two-layered musculus proprius comparable to that of man.

From the Departments of Surgery and Pathology, Harvard Medical School and the Surgical Clinic and Pathological Laboratory, Peter Bent Brigham Hospital.

EXPERIMENTS

Experiments were carried out on more than 50 dogs to study the effects of various degrees of dilatation on the papilla of Vater, liver, and extrahepatic bile ducts. In each dog the papilla was dilated transduodenally by one of the two previously mentioned methods. This was done with and without cholecystectomy and at short and long intervals following removal of the gall bladder. Gross and microscopic studies were made from normal controls. The caliber of the papilla in normal dogs obviously varies with the size of the animal but we have accepted a No. 10 F. as the average in the dogs in this laboratory (Table I). Reports (3, 8, 11, 12, 17, and 18) have indicated that within 120 days cholecystectomy is followed by spontaneous dilatation of the biliary duct system. In order to determine the amount of this dilatation alone, cholecystectomy without dilatation of the papilla of Vater was performed on 6 dogs. After 4 months the size of the papilla had increased to No. 14 F. In the

TABLE I

Type of experiment	No. of animals	Survival days	Ampulla dilated to	Size of ampulla
Control				10 F.
Cholecystectomy	6	120		14 F.
Cholecystectomy and catheter dilatation	7	96	18 F.	10 F.
Cholecystectomy and Bakeš dilatation	5	63	17 F.	12 F.
Catheter dilatation	5	155	21 F.	10 F.
Bakeš dilatation	3	120	23 F.	10 F.
Dilatation and cystic duct drainage	4	92	21 F.	11 F.
Dilatation 200 days after cholecystectomy	6	100	20 F.	12 F.
Acute experiments	15	1–28	22 F.	

first series of experiments, an attempt was made to pass catheters through the stump of the cystic duct. This proved a difficult procedure in the dog, for it was impossible to secure considerable dilatation of the papilla without tearing the common bile duct. Because of this, transduodenal dilatation was used. In 7 dogs, cholecystectomy was followed by dilatation of the papilla with catheters by the transduodenal approach to an average size of No. 18 F. These dogs were examined on an average of 96 days following the operation, and it was found that in all of them the papilla had returned to normal size. The Bakeš metal dilators were used in a group of 5 dogs to dilate the papilla to sizes averaging No. 17 F. Sixty-three days following operation, autopsy showed the papilla to have returned to approximately normal measurements, in this instance No. 12 F.

Since cholecystectomy alone produces an enlargement of the papilla of Vater, the effect of transduodenal dilatation without cholecystectomy was studied. In 5 dogs the papilla was dilated by catheters and in 3 dogs by the use of metal dilators, to No. 21 F. and 23 F., respectively. After a period of at least 4 months, the average measurement of the papilla was found to be No. 10 F.

In a group of 4 dogs, an attempt was made to simulate the method used in the human being by removing the gall bladder and draining the common bile duct by a catheter introduced through the cystic duct. The papilla was then dilated by the transduodenal method, the Bakeš dilators being used, to an average size of No. 21 F. These dogs were sacrificed after a period of 3 months, and it was found that the papilla had returned to No. 11 F. in caliber.

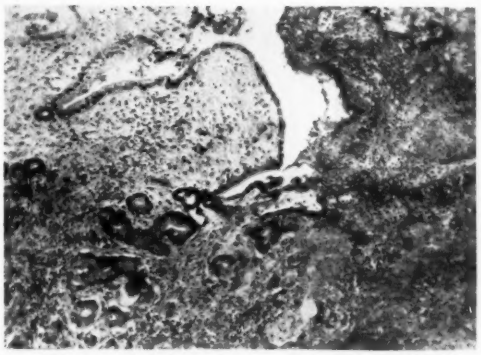


Fig. 1. Photomicrograph of the papilla of Vater 3 days after dilatation with Bakeš instrument. The lumen, at the right, is filled with fibrin and leucocytes. The mucosa is interrupted and shows acute inflammatory reaction. ×90.

The papilla of 6 animals was dilated transduodenally on an average of 200 days after removal of the gall bladder. This was done to determine the effects of dilatation on a pathological biliary system. Graded catheters were passed through the papilla to an average size of No. 20 F. The average size of the papilla 100 days later was only No. 12 F. These experiments indicate that the papilla after extensive dilatation returns to a size smaller than that after cholecystectomy alone.

In addition, a study was made of the immediate effects of dilatation. The papilla was dilated to a No. 22 F. in a series of 15 dogs. These were sacrificed at intervals varying from 1 to 28 days. Gross examination at the time of sacrifice showed, in the first week, that there was a large, edematous papilla protruding into the lumen of the duodenum. No attempt was made to measure the actual size, to obtain microscopic sections which had had no other trauma than that occurring at the original dilatation.

MICROSCOPIC STUDIES

Histologic examination of the papilla of Vater showed that the early changes in the region of the papilla were those of hemorrhage and acute inflammation. In the specimens examined 1 to 3 days after dilatation, the continuity of the epithelium was broken in many places and these intervals were filled with fibrin and polymorphonuclear leucocytes. This exudate was so extensive as to fill the lumen almost entirely (Fig. 1). In addition, there were rather large areas of hemorrhage in the surrounding tissues. The portions of mucosa not eroded showed edema and infiltration with polymorphonuclear leucocytes.

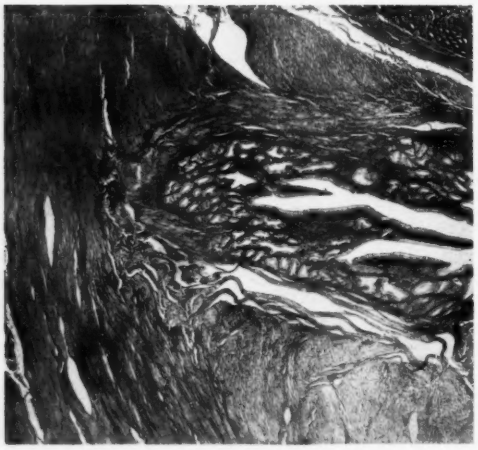


Fig. 2. The normal papilla of Vater of a dog showing intact layers of musculature separating the mucous membrane from the duodenal wall. ×13.

Fig. 3. Papilla of Vater 1 month after dilatation of the papilla with Bakĕs instrument. Note the area of scarring and interruption of the musculature. ×13.

At the end of a week, the lumen of the papilla had reached approximately normal size and most of the exudate had disappeared. The continuity of the epithelium was almost completely restored. In the mucosal stroma there were many lymphocytes but polymorphonuclear leucocytic reaction was slight. There were many fibroblasts and some newly formed capillaries throughout the mucosa and in the layers of muscle ensheathing the papilla. Sometimes these even extended into the adjacent intestinal musculature for a short distance.

After one month considerable scar tissue had formed. This was in contrast to the normal dog's papilla, in which there is an intact investment of muscle about the terminal portion of the common bile duct (Fig. 2). The scar tissue extended through the muscle at intervals and even involved the duodenal muscularis occasionally. The mucosal epithelium was complete but the glands appeared somewhat altered in outline and in the stroma about them were numerous lymphocytes and some plasma cells (Fig. 3).

In the specimens of the papilla from dogs with a greater interval than a month between operation and autopsy, the only further changes were the progressive increase in the collagen of the scar tissue and its retraction. There was no further demonstrable alteration in the contour of the lumen of the duct. The lymphocytic reaction was not noticed after an interval of 2 months.

Sections of the liver were compared with controls from normal dogs and from dogs after cholecystectomy alone. Also, in most experiments biopsies of the liver were obtained. We found no instances of marked hepatitis. In those dogs with strikingly dilated intrahepatic bile ducts there was some increase in connective tissue over that seen in controls but not to a great degree. Lymphocytes were only slightly more numerous about these ducts than in normal controls. The degree of normal variation seemed to us considerable.

CLINICAL APPLICATION

Autopsy statistics show that calculi are overlooked at exploration of the common bile duct in approximately one-third of the cases (14). Because of this, any method which may tend to improve these results seems indicated. The experimental evidence tends to show, at least in animals, that the outlet of the duct is partially blocked by edema and the outpouring of exudate after extensive dilatation. Within a relatively short time the papilla returns to a size smaller than it would have been following cholecystectomy alone. Although such contracture seems a definite possibility, presumably on the basis of scar tissue formation, no serious late results have been recorded attributable to extensive dilatation of the papilla of Vater.

An estimate of the state of the papilla of Vater immediately after dilatation in patients was attempted by the use of the perfusion methods described by Butsch and McGowan. If the papilla is sufficiently dilated to permit the escape

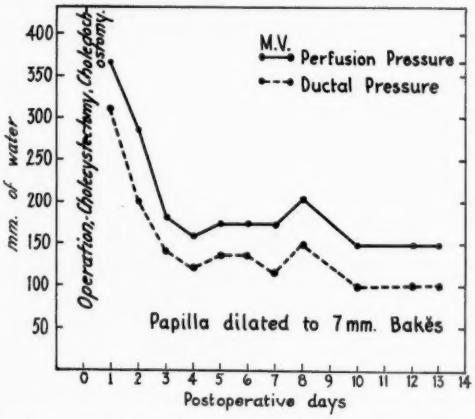


Fig. 4. Chart showing the high initial rise and subsequent fall of the perfusion and ductal pressures in a patient in whom the papilla was dilated to 7 millimeters (Bakes).

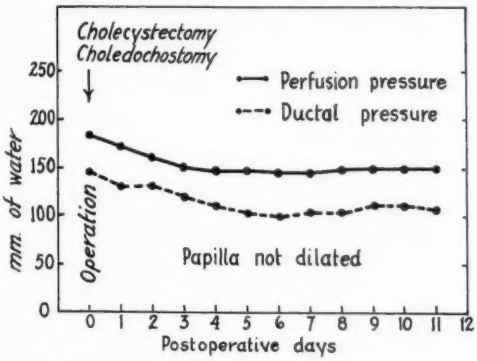


Fig. 5. Chart showing absence of initial rise in perfusion and ductal pressures in a patient in whom choledochostomy was performed without dilatation of the papilla of Vater.

of overlooked calculi it would seem that the perfusion pressure in these patients should be very low. Colp and his associates (7 and 10) have shown that any irritation to the papilla will cause temporary sphincteric spasm. From this it would seem that severe trauma to the sphincter from dilatation may cause prolonged spasm and thus prevent the passage of bile and calculi into the duodenum. Using methods described by Doubilet and Colp (10) and Butsch and McGowan we have followed in patients the pressure necessary to overcome the resistance of the sphincter immediately after dilatation of the papilla. As a control we inserted a catheter into the stump of the cystic duct, or into the common bile duct in other patients to determine the sphincteric resistance when there has been no manipulation. The resistance of the sphincter in a normal human individual is approximately 150 millimeters of water. To avoid the effect of morphine on the sphincter, readings were not taken until 6 or more hours following its administration. In a patient (Fig. 4) in which there had been dilatation of the papilla following choledochostomy to No. 22 F. (Bakes 7 mm.) dilator, the sphincteric resistance was approximately 370 and the persistent ductal pressure was 300 on the day following operation. There was a fall in this sphincteric resistance over a period of several days, but it did not reach a normal level until approximately 4 days following operation. This is also true of the ductal pressure. The findings have been constant in 6 additional cases. In 3 patients in whom we have been able to introduce a very small catheter through the stump of the cystic duct or directly into the common bile duct without manipulation of the papilla, the sphincteric resistance remained at about the normal limits, both on the day of operation and in the following days (Fig. 5). These findings are comparable to the microscopic study, which shows the lumen of the papilla filled with exudate and encroached upon by the edematous mucosa for several days after extensive dilatation of the papilla of Vater. From this it is suggested that in cases in which such dilatation of the papilla has been carried out, the sphincteric resistance does not fall below the normal limits during a period of 2 weeks after operation. As Doubilet and Colp have stated, the hydrostatic pressure caused by the bile does not act against the sphincter but forces the bile through the catheter, since less pressure is required to do this than to overcome the sphincteric resistance.

This resistance, as indicated by our experiments, following the extensive dilatation of the papilla of Vater in patients, suggests that such a procedure would be unwise if plastic operations are to be carried out on the common bile duct. The belief that incisions in the common bile ducts cannot be closed with safety after exploration of this structure may also depend on the increased ductal pressure resulting from morphine during the postoperative period, as shown by Walters and his associates (15 and 19). Irritation from the passage of instruments through the papilla of Vater may increase the pressure still further.

SUMMARY

An investigation has been carried out to determine the effect of extensive dilatation of the papilla of Vater to permit the escape of overlooked

calculi. Experiments on dogs suggest that damage may be done to the papilla of Vater by dilatation, with hemorrhage and inflammation in the acute stages. Later there is scarring, resulting in a smaller opening than that which follows cholecystectomy alone. Clinically, perfusion pressures in patients during the postoperative period following exploration of the common bile duct with dilatation of the papilla show that there is a greater pressure when the papilla is extensively dilated than in those in whom it is not explored. We believe that it is sufficient to determine the patency of the papilla of Vater by the passage of moderate sized instruments instead of attempting to dilate it.

BIBLIOGRAPHY

1. Allen, Arthur W., and Wallace, Richard H. Technique of operation on the common bile duct. Am. J. Surg., 1935, 28: 533–561.
2. Bakeš, J. Zur drainageloesen Gallenchirurgie und der methodischen Dilatation der Papille. Zentralbl. f. Chir., 1928, 55: 1858–1868.
3. Bergh, George S., Sandblom, Philip, and Ivy, A. C. Effects of removal of the functioning gall bladder. Surg., Gynec. & Obst., 1936, 62: 811–814.
4. Boyden, Edward A. The sphincter of Oddi in man and certain representative mammals. Surgery, 1937, 1: 25–37.
5. Butsch, W. L., and McGowan, J. M. Pressure in the common duct; a preliminary report. Proc. Staff Meeting, Mayo Clinic, 1936, 11: 145.
6. Cheever, David. Instrumental dilatation of the papilla of Vater and the dislodgment of calculi by retrograde irrigation. Arch. Surg., 1929, 18: 1069–1077.
7. Colp, Ralph, Doubilet, Henry, and Gerber, Isadore E. Endocholedochal section of the sphincter of Oddi. Arch. Surg., 1936, 33: 696–707.
8. Cox, Forest W. Changes in the bile ducts and parietal sacculi following absence of the gall bladder. Surg., Gynec. & Obst., 1932, 55: 168–176.
9. Davis, Lincoln. Reflux of duodenal contents through the common bile duct. New England J. Med., 1929, 200: 313.
10. Doubilet, Henry, and Colp, Ralph. Resistance of the sphincter of Oddi in the human. Surg., Gynec. & Obst., 1937, 64: 622–633.
11. Halpert, Béla, Rewbridge, Allan G., and Healey, Claire. Effects of cholecystectomy on the biliary system. Arch Surg., 1933, 26: 589–601.
12. Judd, E. S., and Mann, F. C. The effect of the removal of the gall bladder. Surg., Gynec. & Obst., 1917, 24: 437–442.
13. Lahey, Frank H., and Swinton, Neil. Stones in the common and hepatic bile ducts. New England J. Med., 1935, 213: 1275–1280.
14. Mayo, W. J. Surgery of the hepatic and common bile ducts. Lancet, 1923, 1: 1299.
15. McGowan, J. M., Butsch, W. L., and Walters, Waltman. Pressure in the common bile duct of man. J. Am. M. Ass., 1936, 106: 2227–2230.
16. Rost. Ueber instrumentelle Erweiterung der Papilla vateri und Naht des Choledochus nach Choledochotomie. Zentralbl. f. Chir., 1927, 54: 20.
17. Sutton, John E. Changes in the intrahepatic bile ducts following cholecystectomy. Ann. Surg., 1930, 91: 65–72.
18. Idem. Changes in the human intrahepatic bile ducts following chronic cholecystitis, cholelithiasis, and cholecystectomy. Ann. Surg., 1930, 92: 141–147.
19. Walters, Waltman. The pathological physiology of stone in the common bile duct. Surg., Gynec. & Obst., 1936, 63: 417–424.
20. Zollinger, Robert. Significance of pain and vomiting in cholelithiasis. J. Am. M. Ass., 1935, 105: 1647–1652.

CONDUCTION ANALGESIA IN ANORECTAL SURGERY

HARRY E. BACON, B.S., M.D., F.A.C.S., Philadelphia, Pennsylvania

ORIGINATED by Braun and modified by Allen, de Takats, and Werner as infiltration anesthesia, this method is termed conduction analgesia because the injections are made deliberately to analgesize the conducting pathways to the anorectum. Such planned procedure is in contrast to the random injections of infiltration or block analgesia. The term analgesia is used to signify abolition of pain sensation with no loss of cerebral functioning (4). Here the protopathic sensation is retained but the epicritic is lost. Since the conducting pathways are enveloped by the analgesic solution, the nerves are affected by diffusion (8).

This method of analgesia has been employed with excellent results in the surgical treatment of selected cases of internal and external hemorrhoids, prolapse, moderate procidentia, polyps, fissures, fistulas of the simple, straight variety, inflamed crypts, hypertrophied papillas, intra-anal ulcers, condylomas, and skin tags. In divulsion and removal of certain foreign bodies it may also be used. It is not applicable, however, when the extent of the disease process has not been determined before operation, when free suppuration is present, when there are present massive condylomas, multiple and complicated fistulas, or malignant tumors in which extensive surgical intervention is required and the growth is located in the region above the peritoneal reflection. These and such conditions as sequestration dermoid cyst, stricture, procidentia recti, congenital anomalies, and imbedded foreign bodies, are better treated under general anesthesia or spinal analgesia.

PREPARATION

Two hours, and, again, one hour, before operation the patient receives by mouth 3 grains of sodium amytal or 1½ grains of nembutal. At operation, the patient assumes the exaggerated lithotomy position, with the buttocks well over the edge of the table and a large pad under the sacral region. He is then placed in a slight Trendelenburg position and, to add to his comfort, a pillow is slipped under his head so as to raise it to the level of the pubis. In the male, a Drueck binder is applied in order to omit the scrotum from the operative field. The anal and peri-anal skin are then painted with the following solution: picric acid, 5 per cent; acetone, 20 per cent; alcohol, 5 per cent; and water. The excess is dried with sterile gauze.

From the Departments of Proctology, Temple University and Graduate Hospitals.

ANALGESIC SOLUTION

Procaine 1 per cent, or nupercaine 0.1 per cent (1:1000), or metycaine 1 per cent may be used, with the addition of adrenalin in the proportion of 2 to 3 drops to the ounce, to prolong the analgesic effect. The solution should be freshly prepared.

TECHNIQUE

Step 1. With a ¾ inch, 24 gauge hypodermic needle to which is attached a small syringe, an intradermal wheal is raised in the posterior midline, approximately three-quarters of an inch behind the anus. For this, only a few minims of the solution are necessary.

Step 2. A 3 inch, 22 gauge needle attached to a 5 cubic centimeter syringe is introduced through the wheal, and, with the index finger in the anal canal as a guide, the needle is slowly advanced parallel and posterior to the canal for a distance of approximately 1½ inches. At this site, 10 cubic centimeters of the solution are deposited. If the patient feels discomfort, a few minims may be injected as the needle is advanced. The syringe is then detached and the needle is withdrawn up to, but not through, the wheal.

Step 3. With the finger in the rectum as a guide, this same needle is slowly inserted on the left side, deeply, forward, and outward, to the full extent of the needle, depending on the fullness of the buttocks. The syringe, charged with the analgesic solution, is now attached and 5 cubic centimeters are slowly injected into this area. Again the needle is withdrawn up to, but not through, the wheal.

Step 4. The needle is then inserted on the right side and the same procedure is followed as in Step 3. The posterior quadrant has now been completely injected, 5 cubic centimeters being used in the midline and 5 cubic centimeters on either side.

Step 5. With the technique described in Step 1, the second intradermal wheal is raised in the anterior midline, approximately a half inch in front of the anus.

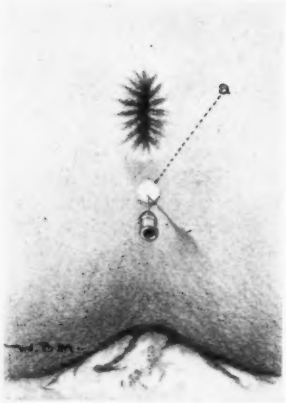


Fig. 1. *a*, An intradermal wheal is raised in the midline behind the posterior aspect of the anus.

Step 6. With the finger in the anal canal as a guide, a 2½ inch, 22 gauge needle is introduced through this wheal and gently advanced parallel to the anal canal for a distance of 1 to 1½ inches. At this site, 5 cubic centimeters of the solution are very slowly deposited. The needle is withdrawn up to, but not through, the wheal.

Steps 7 and 8 are similar to Steps 3 and 4, the needle being inserted first on one side, then on the other, deeply, backward, and forward toward the levator muscle for a distance of 2½ inches. In each area, 5 cubic centimeters of the solution are injected. This completes the analgesia.

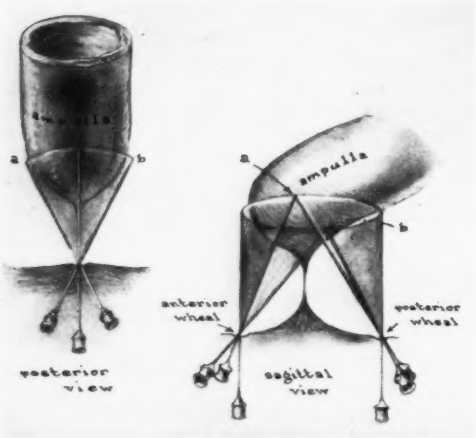


Fig. 3. Posterior and sagittal view of the needles in relation to the anorectal area.

Fig. 2. Sagittal section showing needle inserted in the posterior midline, with finger in lower rectum as a guide.

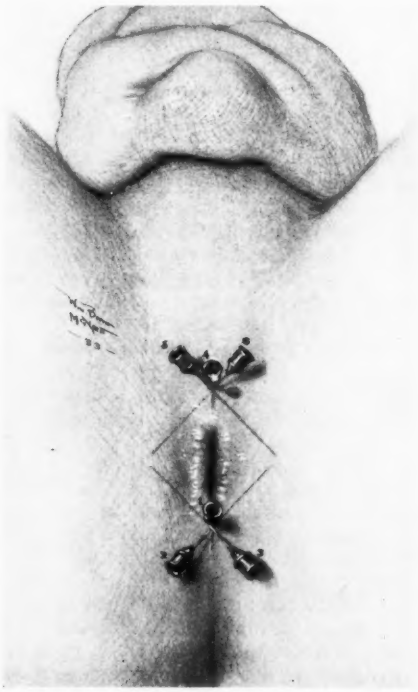


Fig. 4. Appearance of the needles and their direction were they left in place following injection. *1* and *4* needles parallel to anal canal, posteriorly and anteriorly; *2* and *5*, posterolateral injections; *5* and *6*, anterolateral injections.

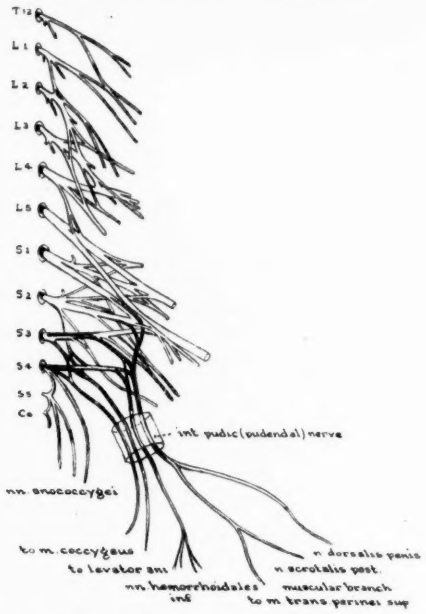


Fig. 5. Nerves to the anorectal area showing their origin in the sacropudendal plexus.

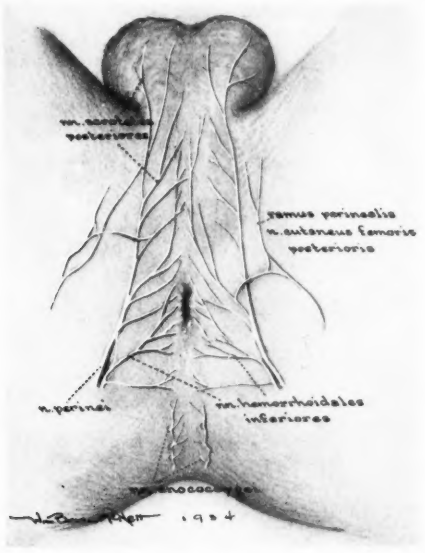


Fig. 6. Distribution and location of sensory nerves of the anal region.

POSTOPERATIVE ANALGESIA

Prolonged analgesia may be obtained by the injection of 5 cubic centimeters of diothane, ½ per cent solution, into the substance of the sphincter muscles (2, 3). In a series of approximately 450 cases treated by the author, freedom from severe pain was a constant feature in all but 11. Similar experiences have been reported (6, 9, 10).

PURPOSE

The anterior and posterior intradermal wheals serve to obtund the skin filaments and render subsequent injections painless. The posterior midline injection interrupts the posterior branch filaments of the inferior hemorrhoidal nerves, the anococcygeal nerves just below their perforation through the sacrotuberous ligament, and the perineal branch of the fourth sacral as it pierces the coccygeal muscle.

The posterolateral injections serve to analgesize the inferior hemorrhoidal nerves at a higher level, together with the perineal nerve and its posterior scrotal or labial branches, and the muscular branches of the dorsal nerve to the penis or clitoris.

The anterior midline injection inhibits the posterior scrotal nerves, its communicating filaments with the perineal branch of the posterior femoral cutaneous and its muscular branch to the superficial transverse perineal muscle.

The anterolateral injections obtund the terminal branches of the perineal nerve, the muscular branches of the dorsal nerve to the penis or clitoris, and the more anterior branch filaments of the inferior hemorrhoidal nerve.

CONCLUSION

In our hands this method has proved of utmost value and is to be highly recommended in all cases in which local analgesia is indicated. There is no pain, distortion, or bulging, and complete muscular relaxation is obtained. The method is simple in the extreme, requiring only careful adherence to technique.

BIBLIOGRAPHY

1. Allen, C. W. Local Anesthesia, p. 413. Philadelphia: W. B. Saunders Co., 1918.
2. Bacon, H. E. Conduction analgesia. Discussion, Tr. Am. Proc. Soc., p. 205, 1935.
3. Idem. Quoted by F. C. Smith, loc. cit.
4. Bickham, W. S. Operative Surgery, vol. 1, p. 85. Philadelphia: W. B. Saunders Co., 1924.
5. Braun, H. Die lokalanaesthesie, ihre wissenschaftlichen Grunellagen. Leipzig, 1907.
6. Hertzler, A. E. The Technic of Local Anesthesia, 5th edit., p. 22. St. Louis: C. V. Mosby Co., 1933.

7. KOSTER, H. Spinal anesthesia. Am. J. Surg., 1928, 5: 554.
8. LABAT, G. Regional Anesthesia, p. 54. Philadelphia: W. B. Saunders Co., 1922.
9. ROSSER, C. Diothane in surgery of anal canal, clinical survey of 100 cases. Surg., Gynec. & Obst., 1934, 59: 820.
10. SMITH, F. C. The use of diothane as a local anesthetic in proctology. Med. Rec., 1935, 139: 5817.
11. DE TAKATS, G. Local Anesthesia, p. 170. Philadelphia: W. B. Saunders Co., 1928.
12. WERNER, J. Local anesthesia in anorectal surgery, modified technic. Tr. Am. Proc. Soc., 1935, p. 203.

THE TREATMENT OF FISTULAS OF THE SMALL INTESTINE

JOHN B. HARTZELL, M.D., F.A.C.S., Detroit, Michigan

THE occurrence of a fistula of the small intestine in an abdominal wound is a distressing complication. The seriousness of such a fistula depends upon its situation in the intestinal tract. The higher the location the greater the menace it constitutes to the life of the patient.

A high small intestinal fistula may have a rapidly deleterious effect upon the general health. In certain cases, practically everything taken by mouth is almost immediately expelled through the fistula with the result that speedy malnutrition occurs. More important than the loss of food is the enormous loss of fluid containing gastric and pancreatic juice, bile and intestinal secretion. This means a loss of the sodium and chloride ions so necessary in maintaining the fluid volume of the tissues. This results in prompt and severe dehydration and serious changes in the acid base balance of the blood plasma (14). There occurs a rise in the blood nitrogen and a drop in the blood chlorides so that early treatment is required or death soon follows. The loss of bile and intestinal secretion further depletes the body fluids but the continued loss of pancreatic juice has been shown to be fatal (13, 41). The situation, as has been shown by Morton and Pearse, closely resembles that found in instances of high intestinal obstruction when the loss of food, fluid, and secretions is by vomiting instead of by way of a fistula.

In addition to the effect of a high small intestinal fistula upon the general condition of a patient, there is a local effect of the intestinal content upon the tissues as it exudes through the wound. This material is rich in enzymes and digests the tissues of the abdominal wall, often dissecting under the skin or fascia many inches to either side of the wound. As the secretions pour out upon the abdomen they also attack the skin, causing widespread and painful excoriations. Secondary infection often results. The patient becomes rapidly toxic, and, added to this physical suffering, there is the additional burden of mental anguish as the patient realizes that some serious complication has occurred.

The treatment of small intestinal fistulas has been reviewed by Ochsner (27) and by McIver. It is most important that the general condition of the patient be constantly watched. Active supportive measures should be started immediately. The fluid loss must be made up. This is best accomplished by the administration of large quantities of intravenous fluid. A 5 per cent glucose solution intravenously, from 2 to 6 liters daily may be necessary to keep the blood nitrogen within normal limits. The blood chlorides should not be allowed to drop below 400 milligrams. This necessitates the daily administration of salt solution, which is best given as normal saline, intravenously or subcutaneously. If the patient is greatly dehydrated, a fair amount may be absorbed by proctoclysis, which should be given slowly, as a Murphy drip. Blood transfusions may also be of benefit. With constant attention to these important features in the patient's care, the problem of the treatment of the fistula itself must be dealt with.

If the fistula is small, the use of the prone position on an anterior Bradford frame as suggested by Potter (33) may aid in preventing digestion of the skin. Many substances have been applied to the skin as a protection against this local irritation and among the more widely used are

Read before the Surgical Section of the Michigan State Medical Society. September 24, 1936.

various ointments and powders. Zinc oxide is the most frequently used. Lorch uses destin ointment combined with intensive irradiation. Smith and Christensen use kaolin and glycerin. The more extensively used powders are copper bronzing powder advocated by Cunningham. Many substances have been used to inactivate or neutralize the irritating qualities of the discharge. Egg albumen locally and by mouth has been used by Ochsner (28). Dried milk has been used by Rees and others. Potter (32) applies one tenth normal hydrochloric acid to the skin, and inserts a tampon saturated with beef broth into the fistula. Warshaw and Hoffman, Fox (12), and others report favorably upon the use of Potter's (32) method, some using peptone instead of beef broth.

Patel and Carcassonne report the cure of one serious case by oral administration of fractional doses of 12 grams of calcium chloride per day. In addition, 10 units of insulin were given daily. These authors do not discuss the theory of this treatment. However, it is probably based upon supposed inhibitory effect of large doses of calcium upon motor and secretory activity of the gastro-intestinal tract (4). Dietary restrictions are of little benefit. Continuous aspiration of the secretion by means of a catheter has been successfully employed by Erdman, Cameron, Cheever, Lahey, Walters and Kilgore, Walters and Bollman, and Ochsner. The use of two catheters, one in the efferent and one in the afferent loop so that the intestinal contents are redirected into the bowel, has been employed by Wilkie. Volkman and Peet favor this method.

The artificial closure of the fistula by various means has been tried by many authors. The use of Beck's paste as described by Baker is an excellent method if the fistulous tract is over an inch in length and not of too great a diameter. Judd and Phillips have used chewing gum. Plugging the fistula with gauze soaked in oil has been advocated by Rigby, Hendon, Stadler, and Fechen. Johnston describes a method of temporary closure of a fistulous opening consisting of a two way catheter, the openings of which are connected with two small balloons, one at the end and the second situated about 1.5 centimeters proximally. The inner balloon is introduced into the lumen of the bowel and is then inflated with a small amount of air, an amount just sufficient to allow it to be pulled easily into the fistulous tract but not out of it. The outer balloon is then inflated so that the whole balloon lies wholly upon the abdominal wall, thus holding the inner balloon firmly in place and sealing the fistulous opening.

There is another method of dealing with a high small intestinal fistula which, though not always feasible, may often prove a life saving measure. This is the artificial closure of the opening by means of a button or small plaque inserted into the lumen of the gut and pulled back against the opening by means of a suture which is allowed to emerge through the fistula. Though not always practical, this procedure is well worth a trial. Pamperl reports the case of Reybard, who over a hundred years ago advocated the closing of an abdominal wound which penetrated through the wall of the intestine by inserting a wooden button into the lumen of the gut. The button was then pulled back snugly against the opening with a suture which passed out through the skin wound and was fastened to a crossbar lying on the surface of the abdomen. Kleybolte, in 1842, described a similar device made of leather. Another method of artificial closure is by the use of a T tube as first advocated by Kappis in 1911. He inserted the horizontal portion into the lumen of the bowel and allowed the vertical portion to protrude through the abdominal fistula. Eliot has used this method. Kaehler and Pamperl have used a rubber tube split in half. Ahrens believes that the T tube is preferable as it tends to depress the mesenteric wall of the bowel where often there is a tendency to spur formation at the junction of the efferent and afferent loops. Dowd in 1917 describes a small disc which he inserted into the lumen of the bowel and held against the opening with a suture which passed through a small obturator, or hollow axle-like shank of the right length and was tied to a second disc on the skin. C. H. Mayo (24) in the same year used the Dowd button. Cattell reports the successful use of this button in several cases. C. W. Mayo (25) used a bakelite button in the closure of a gastrostomy opening. The success of these various devices depends upon having a relatively small opening in the bowel with moderately firm tissue about the opening against which the button may be pulled. If the hole is large, involving one-half of the circumference of the bowel for instance, or if it is situated at an angulation, such a button will not stay in place. A T tube in this instance is also of little value. With a large opening the liquid bowel content leaks about the tube and the pressure of the tube against the friable inflamed bowel wall causes further necrosis.

Surgical procedures at this time are fraught with serious dangers and with small chance of cure. The bowel may be visible but the walls are usually so inflamed that any attempt to free the margins and close the opening by suture results

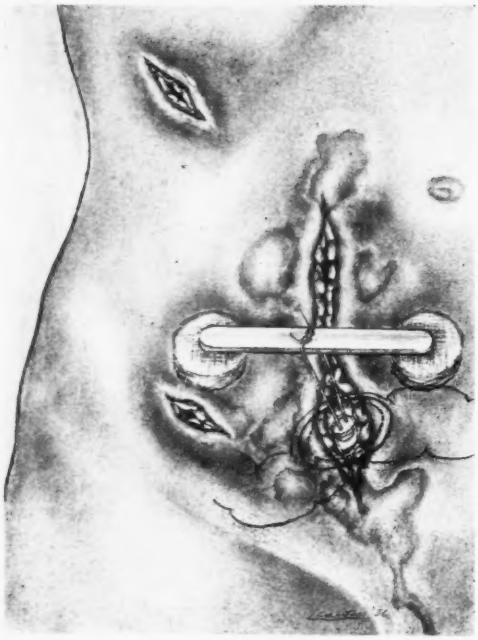


Fig. 1. Case 1. Condition of the abdominal wound at the time the rubber disc was first inserted. The opening in the bowel is visible in the lower angle of the wound. The rubber disc is shown in the outline held in place within the lumen of the bowel by a suture which emerges through the opening and is tied to a crossbar on the surface of the abdomen. There is a marked excoriation of the skin. The two counter incisions are shown, one below the right costal border, and one in the right groin. The intestinal drainage had dissected under the skin to these areas and abscesses had formed.

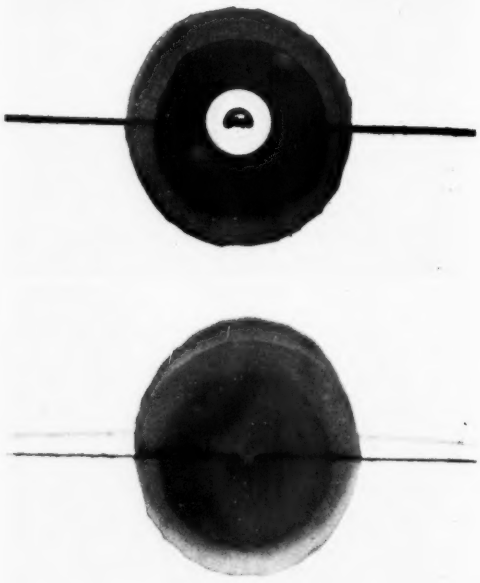


Fig. 2. The rubber disc which was used in Case 1.

in the tearing of the bowel and increasing the size of the fistula. If the abdomen is opened with the idea of excising the fistula and doing an anastomosis or an enterostomy, there is the serious possibility of contamination with resulting peritonitis. Many operative procedures have been suggested, but any radical surgery is obviously contra-indicated except when there is an obstruction lower down in the efferent segment. Rokhkind lists a second exception; namely, when the defect in the intestinal wall is so large that the entire content is lost externally.

If there is any possibility of an obstruction in the efferent loop its presence should be determined at the earliest possible moment. Such an obstruction may be responsible for the appearance of a fistula in the first place. The wall of the exposed loop of bowel in an open infected wound is much more likely to give way if there is an obstruction distal to it, than if the bowel lumen is patent. Therefore, if an obstruction is suspected, it is well to insert a catheter through the fistula and into the efferent loop and inject an ounce or two of mineral oil. This will appear rectally if there is no obstruction. If the oil does not appear, immediate operation for the relief of the obstruction is imperative, as any attempt at closure of the fistula either by artificial or surgical means is futile. It may be possible to locate the exact site of the obstruction by injecting a small amount of barium into the efferent loop and following its course with the x-ray. The longer the delay the greater the certainty of a fatal outcome. However, if it could be determined that the obstructed area was situated well away from the fistula, it might prove more practical to make the incision directly over the obstructed area, do an enteroanastomosis about it, and rely on artificial closure of the fistula. Then as the general condition of the patient improved this could be closed later if it did not close itself.

So much for the necessity of immediate surgical interference. Now to consider the small intestinal fistula with an opening so large that the entire

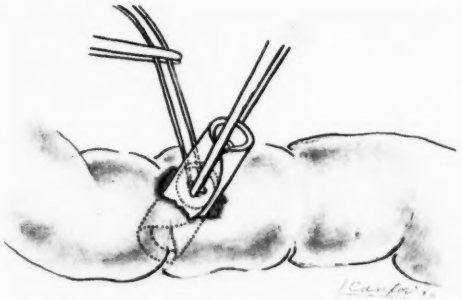


Fig. 3. The rubber disc has been rolled up and it is being inserted into the lumen of the bowel.

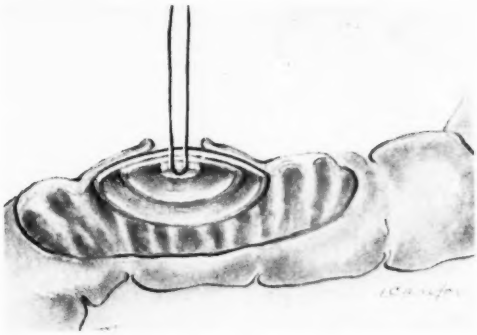


Fig. 4. A sagittal section showing rubber disc inside the lumen of the bowel and pulled against opening by a suture which passes out through the fistula.

content of the afferent loop is lost externally. We have devised a refinement of the button and tube method of artificial closure which may work where these may not. Let us consider such a fistula situated at a knuckle and involving about half the circumference of the bowel with a gaping and infected wound from which the intestinal contents flow in an almost uninterrupted stream. First we introduce a probe into the bowel to determine the approximate size of the lumen and the angle at which the afferent and the efferent loops meet at the opening. We then mold a wax model of the proper size and proper angle and with sufficient belly to receive the intestinal content from the efferent loop and shunt it around the corner into the afferent loop. This mold must be long enough to extend well beyond the area of the necrotic bowel. The general shape may be that of a half tube or an angulated tube from which a longitudinal strip, the width of a quarter to a half of the circumference, has been cut away. This wax model is then cast in pliable rubber which is easily folded up and inserted into the bowel but is stiff enough to return to and maintain its original shape. Into the exposed portion we place a heavy silk suture which is allowed to emerge through the fistula and is fastened to a crossbar on the surface of the abdomen. If the rubber cast does not stay in place, two sutures, one through either end and brought out through the bowel wall and abdominal wall will hold it there. The wound is then approximated with one or two large sutures or possibly a strip of adhesive tape. The leakage stops, the intestinal content is diverted into the bowel below the fistula. The general condition of the patient improves. The wound rapidly loses its angry appearance. With a little ointment on the skin and irrigation of the wound, granulations soon appear and bridge across. After a short time the condition of the tissues may be so improved as to warrant surgical closure of the opening. Or if the opening is closing and becoming smaller, this cast may be withdrawn and replaced with a smaller one. When the granulations grow snugly about the thread, the latter may be cut, the button passes, and the fistula soon seals itself and heals completely. We feel this to be an improvement in the treatment of high intestinal fistulas as compared to early and more radical procedures.

SUMMARY

The treatment of small intestinal fistulas has been reviewed.

The presence of an obstruction distal to the site of a fistula constitutes the one all important reason for immediate surgical interference.

The practicability of closure of a small intestinal fistula by artificial means is stressed.

In the presence of a large fistulous opening, where other types of artificial (button) closure are unsatisfactory, the use of the rubber cast as described here, may prove a life saving measure.

Four cases are reported.

CASE 1. A male, 30 years old, was operated upon for subacute appendicitis. The operation was easily performed through a right rectus incision. An intestinal obstruction occurred. The patient was again operated upon on the fifth postoperative day. The obstruction was found to be due to an old fibrous band which constricted the small bowel at the level of the lower jejunum. This band was cut and the bowel freed. Just proximal to the band was a necrotic area which perforated spontaneously. The margins of this opening could not be approximated. An entero-anastomosis was made between this portion of the bowel and an empty loop distal to it. The anastomosis worked very well. Four other smaller perforations occurred in the distended necrotic bowel above the anastomosis. It was possible to close

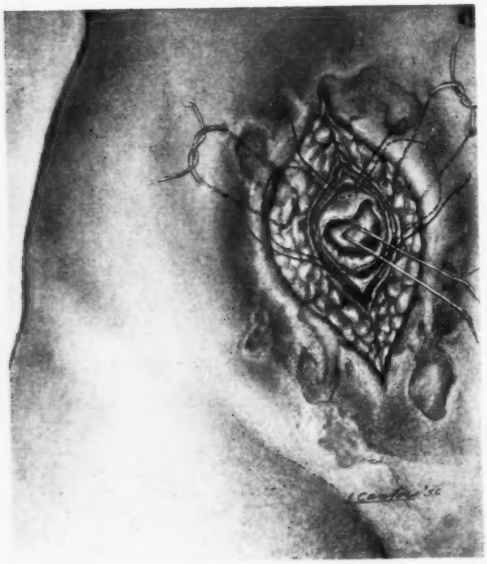


Fig. 5.

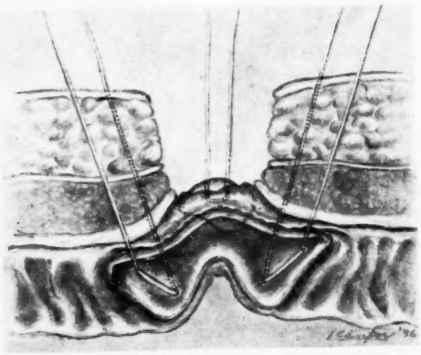


Fig. 6.

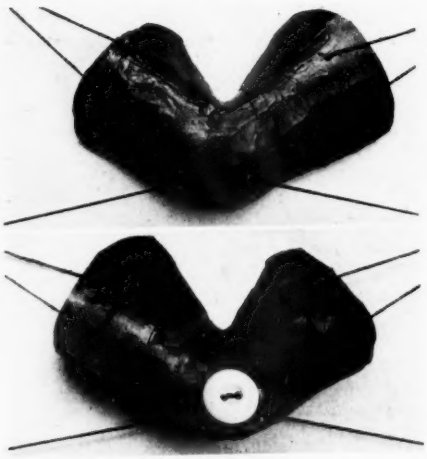


Fig. 7.

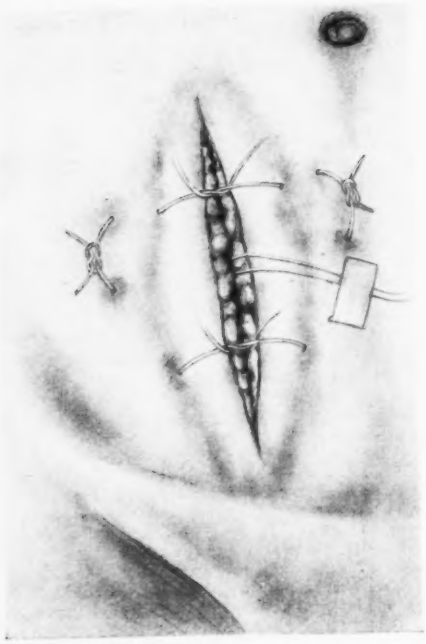


Fig. 8.

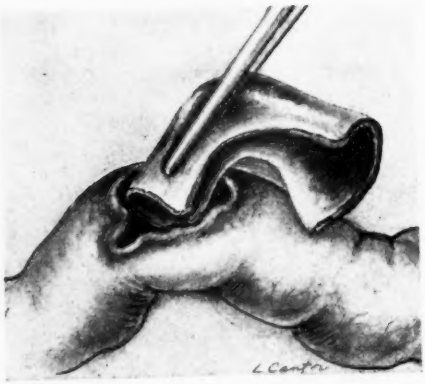


Fig. 9.

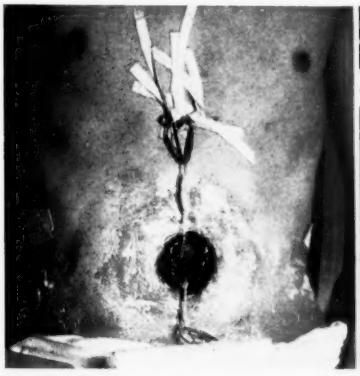


Fig. 10.

Fig. 14.

Fig. 11.

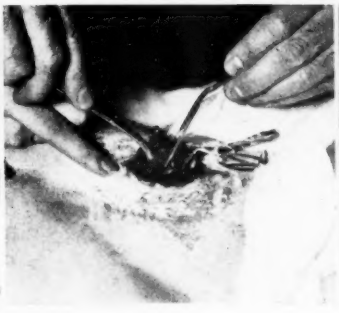


Fig. 12.

Fig. 13.

Fig. 5. Case 2. Condition of the abdominal wound at the time the rubber cast was first inserted. A knuckle of bowel is visible in the base of the wound. The top of this knuckle has sloughed off leaving a large hole. There is marked excoriation of the skin. The rubber cast is shown in place within the lumen of the bowel, held in place by a suture through either end which passes out through the bowel wall and the abdominal wall. There is a third suture fastened to the cast at the knuckle. This emerges through the fistula. This suture was later tied to a crossbar on the surface of the abdomen.

Fig. 6. Sagittal section showing the rubber cast inside the lumen of the bowel. The sutures through either end of the cast pass out through the bowel wall and abdominal wall, and are tied on the skin. The central suture emerges through the fistula and is tied to a crossbar on the surface of the abdomen.

Fig. 7. Two views of the rubber cast used in Case 2.

Fig. 8. The insertion of the rubber cast into the lumen of the bowel.

Fig. 9. Case 2. Condition of the abdominal wound after the cast had been in place 1 week. There is no leakage and the condition of the wound is greatly improved.

Fig. 10. Case 3. Condition of wound when patient came to the hospital after wearing a rubber button for over 8 months. He took care of this himself, and this shows his own method of fastening it in place.

Fig. 11. Case 3. Button has been withdrawn, and the skin of the abdomen has been immediately flooded with intestinal contents.

Fig. 12. Case 3. Button being inserted into the lumen of the bowel.

Fig. 13. Case 3. The button is within the lumen of the bowel and is held in place by the attached string.

Fig. 14. Case 3. Appearance of the abdominal wound 3 weeks after operation.

all these except one. The tissue about this was so friable that it was impossible to approximate the margins. A soft catheter was inserted through this hole into the lumen of the bowel, and brought out through the omentum which was tucked over this whole portion of discolored inflamed bowel. This catheter was brought out through the wound as an enterostomy. The enterostomy tube worked well. The wound became infected with colon bacilli which necessitated the removal of several stitches, and on the sixth day a fecal fistula occurred. The opening in the bowel could be seen in the lower angle of the incision (Fig. 1). Food and fluids came through this opening within 5 minutes after being taken by mouth. The wound infection progressed. There was a copious amount of intestinal drainage pouring from this opening in a nearly constant stream. This material was very irritating. It excoriated the skin and dissected

Fig. 15.

Fig. 16.

Fig. 17.

Fig. 18.

Fig. 15. Case 4. The soft rubber button is in place within the lumen of the bowel. It is pulled back against the opening by means of a black silk thread, which emerges through the upper angle of the wound.

Fig. 16. Case 4. The wound strapped and thread held by a strip of adhesive tape above the upper angle.

Fig. 17. Case 4. The tension has been removed from the thread, and the wound and drapes have been flooded with intestinal content.

Fig. 18. Case 4. Appearance of the wound 3 weeks after insertion of the button. It is well healed, except for a small granulating sinus at the upper angle, through which the thread emerges. Three days after this picture was taken the thread was cut. The wound was healed within a week.

under it to either side of the wound. A tender mass appeared below the right costal border and a second in the right inguinal region. These were incised and drained. They proved to be abscesses and were connected with the wound.

The patient lost ground rapidly. The blood nitrogen mounted. The enterostomy tube stopped draining and was removed. Many different ways of dressing the wound were tried but the drainage was so copious that the surface of the abdomen was almost constantly flooded with this irritating intestinal content. Finally a soft rubber button was devised out of two layers of rubber tissue (Fig. 2). This disc or button was then rolled up and inserted into the lumen of the gut (Fig. 3) and pulled back against the opening in the bowel (Fig. 4) by means of a suture which was allowed to emerge through the incision and was fastened to a crossbar on the surface of the abdomen (Fig. 1). The drainage of intestinal content stopped immediately. The patient's general condition rapidly improved. The wound infection cleared up. Healthy granulation tissue soon grew firmly about the thread. Six weeks after the insertion of this rubber disc the suture was cut and the button passed. The fistula had sealed itself. One week later the patient was without a dressing.

CASE 2. A male, 42 years of age, was operated upon by a colleague for chronic appendicitis and to free abdominal adhesions. On the tenth day a wound infection developed. The wound was probed—gas and fecal matter escaped. He was first seen in consultation 2 weeks after the operation. The fistula had been discharging for 4 days. There was a large gaping infected wound with marked excoriation of the skin. The opening in the bowel which was visible was large and situated at an angulation. All foods and fluids taken by mouth were soon lost through the fistula. The ordinary

type of button would not stay in place. A rubber cast was made from a wax model as previously described (Fig. 7) and inserted into the bowel (Fig. 9). A suture was first placed through the angle or knuckle of the rubber cast to hold it. This was at first anchored to the skin with a tab of adhesive tape (Fig. 8). It was later tied to a crossbar in order to pull the cast more snugly against the opening in the bowel. Two more sutures were then placed in the cast, one through either end (Fig. 7). These were brought out through the bowel wall and abdominal wall (Figs. 5 and 6) and tied in place (Fig. 8). The wound was loosely approximated. There was only a slight amount of leakage thereafter. The general condition of the patient improved. The condition of the wound improved so much that a simple secondary closure was performed 2 weeks later. This was successful and the patient was able to leave the hospital on the fifteenth day.

CASE 3. A male, 17 years of age, was shot through the body with a No. 22 rifle. The bullet entered just to the left of the twelfth thoracic vertebra, passed through the pleural cavity, perforating the lower lobe of the lung, diaphragm, liver and stomach, and emerged through the fifth interspace in the left nipple line. An abdominal exploration was performed a few hours later and the stomach perforations were sutured. The postoperative course was stormy, with fever, 102 degrees and distention of the abdomen. On the eighth day the patient suffered a severe hemorrhage from the stomach necessitating a transfusion. On the tenth postoperative day the wound opened up and was resutured. Five days later a fecal fistula appeared, and patient was put on a Bradford frame. At the end of the third week he developed an empyema of the left thoracic cavity. Closed drainage was instituted. In the fourth week an appendiceal abscess was discovered and drained. All this while the fistula was draining copiously. I first saw the patient in consultation with regard to the fistula, approximately 1 month after his accident. At that time he had a large fecal fistula in an upper abdominal wound. His weight had dropped from 108 pounds to approximately 50 or 60 pounds, and he was in a truly pitiful condition. Ointments, powders, suction, in fact a long list of things had been tried with little or no success. The mucous membrane had grown to the skin as in a permanent colostomy (Fig. 10). The opening was about the size of a half dollar. A rubber cast was made and inserted. From that day the general condition of the patient gradually improved. During the course of the next month 3 operations were performed. The right lower quadrant was explored, a rib resection was done, and open drainage of the empyema was instituted. Also, a left subdiaphragmatic abscess was drained. Four months after the accident the patient was able to leave the hospital. By this time he had worn the button for 3 months and was looking after it himself. Sometime later he made one for himself out of an inner tube. He wore this button until June, 1937. He was able to ride a bicycle and play golf. His general condition improved so much that early in June the incision was opened. The fistulous opening was excised together with about 3 inches of bowel proximal and distal to the opening. An end-to-end anastomosis was performed and the patient was able to leave the hospital with a healed wound in about 2 weeks. This case affords an excellent example of the value of this rubber button type of closure. It was worn continuously for over 8 months, during which time the patient underwent three serious major operations. He recovered and gained in general strength sufficiently so that he was able to go home and lead a fairly normal and comfortable existence until his general health had improved to such an extent as to permit him to withstand a resection of his bowel.

CASE 4. A colored female, aged 29 years, was admitted to the hospital with a strangulated umbilical hernia, with a two day history of abdominal pain, emesis, and fever. The white blood count was 14,700, and the polymorphonuclear count was 92 per cent. An operation was performed within a few hours. A small incision was made over the mass just above the umbilicus. A small loop of jejunum was found incarcerated in a sac. It appeared black but was thought to be viable. It was dropped back and the hernia repaired. The postoperative course was stormy—fever, 101 to 103.6 degrees; pulse, 100 to 140, marked abdominal distention partially relieved by Wangensteen suction. A bronchopneumonia and pleurisy developed. The general condition improved slightly. On the tenth postoperative day the pulse was still elevated, and the abdomen still distended. On the twelfth postoperative day, a fecal fistula appeared in the wound. This drained more copious amounts each day. The patient was given 3000 to 4000 cubic centimeters of intravenous glucose and saline daily. However, 1 week later, in spite of this intensive treatment, the blood urea was 121.7 milligrams per cent and the blood chloride was 346.5 milligrams per cent. She was seen in consultation on this same day. The wound was open, the fistula visible in the base of the wound. It was impossible to keep the wound dry, and there was much necrotic tissue along the margins of the wound. Several times in the course of inspection of the wound, 100 to 200 cubic centimeters of intestinal content gushed out, flooded the abdomen, and ran into the bed. The fistula was about 1 centimeter in diameter. It was explored with the finger and found to arise from a slightly constricted portion of the bowel. The bowel for a distance of about 2 centimeters to either side of the fistula felt firm and indurated. Beyond that it seemed to be normal. A soft rubber button was made similar to the one devised for Case 1. It was rolled up and inserted into the lumen of the bowel, and pulled back by means of the attached thread which was fastened to the skin. The patient's condition remained about the same for 2 days. The temperature and pulse remained elevated; temperature, 101 to 104 degrees; pulse, 110 to 120. A continuous intravenous infusion was started, and within 2 days she appeared much improved. The temperature and pulse levelled off to normal, and in 3 days the blood urea had dropped from 121.7 milligrams per cent to 49.2 milligrams per cent, and the chlorides had risen from 346.5 milligrams per cent to 412.5 milligrams per cent. The wound rapidly cleared up. The button came out two or three times in the first 48 hours. After that it remained in place, and there was no leakage. The wound margins were approximated with adhesive tape and a cod liver oil and vaseline dressing was applied. Three weeks from the time the button was introduced, the wound was healed except for a small sinus through which the thread passed out and was fastened to the skin of the abdomen. The patient was up and about. At this point the thread was cut, the button passed, and the patient was completely healed within a week.

BIBLIOGRAPHY

1. AHRENS, P. New viewpoints in treatment of duodenal and high jejunal fistula and operative fistula in general. Zentralbl. f. Chir., 1925, 52: 1886–1889.
2. BAKER, H. L. Repair of intestinal fistulas. Ann. Surg., 1932, 95: 687–699.
3. CAMERON, A. L. Treatment of duodenal fistula: with report of a case. Surg., Gynec. & Obst., 1923, 37: 599–606.
4. CAUTAROW, A. Calcium Metabolism and Calcium Therapy. p. 134. Philadelphia: Lea & Febiger, 1931.

5. CATTELL, R. B. Button closure of small intestinal fistula. Surg. Clin. N. America, 1934, 14: 1105.
6. CHEEVER, D. Concerning traumatic rupture of duodenum and duodenal fistula with the report of a case. Boston M. & S. J., 1915, 173: 454–457.
7. CUNNINGHAM, W. F. The prevention and treatment of abdominal wall excoriation in gastric and intestinal fistulas by copper bronzing powder. J. Am. M. Ass., 1932, 98: 1643.
8. DOWD, CHARLES N. Enterostomy for ileus. Ann. Surg., 1917, 45: 95–104.
9. ELIOT, E., JR. Fistulas of the small and large intestine. Ann. Surg., 1927, 86: 406–412.
10. ERDMAN, S. Laceration of the duodenum; rupture of the liver; duodenal fistula; jejunostomy feeding; parotiditis; recovery. Ann. Surg., 1921, 73: 793–795.
11. FECHEN, K. Treatment of intestinal fistula with oil tampon. Med. Klin., 1925, 21: 891.
12. FOX, R. H. Treatment of fecal fistula. J. Oklahoma St. M. Ass., 1931, 24: 45–47.
13. GAMBLE, JAMES L., and MCIVER, MONROE A. Loss of external secretion of the pancreas. J. Exper. Med., 1928, 48: 859–869.
14. Idem. Acid base composition of pancreatic juice and bile. J. Exper. Med., 1928, 48: 849–857.
15. HENDON, G. A. Duodenal fistula with case report. Tr. South. Surg. Ass., 1919, 31: 169–179.
16. JOHNSTON, CHARLES G. A method for making quantitative intestinal studies. Proc. Soc. Exper. Biol. & Med., 1932, 30: 193–196.
17. JUDD, E. S., and PHILLIPS, J. R. A new method of improving the condition of the abdominal wall preliminary to closure of intestinal fistula. Surg. Clin. N. America, 1934, 14: 521–525.
18. KAEHLER, M. Einige pracktische Winke zur Behandlung des peritonitischen Ileus. Muenchen. med. Wchnschr., 1911, 58: 515.
19. KAPPIS, MAX. Einige pracktische Winke zur Behandlung des peritonitischen Ileus. Muenchen. med. Wchnschr., 1911, 58: 15–17.
20. KLEYBOLTE. Cited by Pamperl.
21. LAHEY, F. H. Treatment of duodenal fistula by suction. Surg. Clin. N. America, 1924, 4: 1489–1492.
22. LORCH, L. Fistula of the large intestine cured by "filling" and irradiation. Zentralbl. f. Chir., 1929, 56: 1614.
23. MCIVER, M. A. Acute Intestinal Obstruction. Pp. 316–318. New York: Paul B. Hoeber, Inc., 1934.
24. MAYO, C. H. Enterostomy and the use of omentum in the prevention and healing of fistula. Ann. Surg., 1917, 66: 568–570.
25. MAYO, C. W., WILBUR, D. L., ZELLHOEFER, H. W. K. Proc. Staff Meet. Mayo Clin., 1935, 10: 625–629.
26. MORTON, J. J., and PEARSE, H. E. Similarity in the effect of experimental high intestinal obstruction and high complete intestinal fistula. Ann. Surg., 1931, 94: 263–268.
27. OCHSNER, A. J. Surgery of the intestines. Nelson's Loose Leaf Living Surgery, 5: 243–296.
28. Idem. Intestinal fistula Surg. Clin. Chicago, 1919, 3: 699–703.
29. PAMPERL, R. Treatment of high intestinal fistulas. Zentralbl. f. Chir., 1925, 52: 2402–2404.
30. PATEL, M., and CARCASSONNE, F. Anterior duodenal fistulas and their treatment. Paris méd., 1929, 37: 221–226.
31. PEET, M. M. The problem of nutrition and satisfactory method of feeding in high intestinal fistulas. Am. J. M. Sc., 1919, 157: 839.
32. POTTER, C. Treatment of duodenal fistula; report of a case. J. Am. M. Ass., 1927, 88: 899–901.
33. POTTER, E. B. Intestinal fistulas, a method for preventing digestion of the skin. Ann. Surg., 1932, 95: 700–703.
34. REES, C. E. Dried milk as a dressing for intestinal fistula; report of a case. Calif. & West. Med., 1929, 30: 419.
35. REYBARD, B. Cited by Pamperl, R.
36. RIGBY, SIR H. M. A note on external duodenal fistula; with report of some unpublished cases. Brit. J. Surg., 1924, 12: 43–51.
37. ROKHKIND, E. The treatment of external fecal fistulas. Vestnik. Khir., 1931, 24: 81.
38. SMITH, J. F., and CHRISTENSEN, H. H. Intestinal fistulas; a method of preventing skin excoriation. Surg., Gynec. & Obst., 1926, 43: 701–702.
39. STADLER, E. Treatment of high intestinal fistulas with oil tampon. Schweiz. med. Wchnschr., 1921, 51: 978.
40. VOLKMAN, J. Treatment of fistula of the duodenum and ileum. Zentralbl. f. Chir., 1927, 54: 130–131.
41. WALTERS, W., and BOLLMAN, J. L. Toxemia of duodenal fistula; physiological changes concerned in production of its characteristic chemical reactions of the blood. J. Am. M. Ass., 1927, 89: 1847–1853.
42. WALTERS, W., KILGORE, A. M., and BOLLMAN, L. Changes in the blood resulting from duodenal fistula; a clinical and experimental study. J. Am. M. Ass., 1926, 86: 186–191.
43. WARSHAW, D., and HOFFMAN, W. J. High intestinal fistula; report of a case treated by modification of Potter method. J. Am. M. Ass., 1930, 94: 1050–1052.
44. WILKIE, D. P. D. Temporary extra-abdominal intestinal anastomosis through a tube. Brit. J. Surg., 1924, 11: 568.

UTERUS BICORNIS DUPLEX ASSOCIATED WITH INFECTION DUE TO MICRO-AEROPHILIC HEMOLYTIC STREPTOCOCCUS

EDWARD B. SELF, M.D., and FRANK L. MELENEY, M.D., F.A.C.S., New York, New York

CONGENITAL malformations of the uterus have been classified in various ways by different authors. The following grouping, suggested by Strassmann, appears to be the most satisfactory:

1. Uterus septus—the septum extends through the body of the uterus and the cervix. It may or may not pass down to divide the vagina in half.

2. Uterus subseptus—the septum is incomplete.

3. Uterus bicornis—a uterine horn is free on both sides. Depending upon the degree of separation and non-union of the horns there result here the following subgroups:

a. Uterus arcuatus—there is simply a slight indentation or notch in the fundus, resulting in a heart-shaped uterus.

b. Uterus bicornis unicollis—the indentation further separates the two horns, they being joined at a point only a short distance above a single cervix.

c. Uterus bicornis duplex—the horns are further separated, but the adjacent walls are fused just above the cervical level. There are two distinct cervices and there may or may not be two vaginas.

d. Uterus didelphys—there is complete separation of the horns with formation of a true double uterus. There are two cervices and two vaginas. This anomaly is the rarest of all.

No attempt will be made here to discuss the embryology of the uterus in detail. Suffice it to say that most uterine malformations are the result of improper fusion of the two muellerian ducts, resulting in an accentuation of what are called horns in the adult uterus. Many theories have been advanced to explain the factors responsible for this failure of fusion of the ducts, and among them the following seem most worthy of mention. In the case of many of the theories, the proponents have failed to advance tangible evidence in support of their ideas.

1. Prominence of a rectovesical ligament. This ligament is frequently found between the two horns of a normal single uterus, and between those of a bicornate uterus. However, this ligament might just as well be a part of the anomalous condition itself as its cause.

2. Fetal peritonitis, the resulting adhesions preventing fusion of the ducts. This course of events must be exceedingly rare, if indeed it occurs at all.

3. Abnormal persistence of a cloaca, or

4. Disturbance of development of the intestinal tract or bladder, the abnormalities thus preventing normal union of the two ducts.

5. Too short round ligaments, or

6. A broadening (widening) of the bony pelvis, again preventing proper fusion.

7. Variations in the germ plasm itself.

It is probable that one or more of these factors play a part, varying in different instances.

Congenital malformations of the uterus are not rare, but relatively few cases are recognized during life. Statistics as to their frequency are confusing because the exact nature of the anomaly is not always accurately described by the author, and there is often disagreement as to which name should be applied to the particular anomaly in question. Various statements occur in the literature concerning the frequency of the rarest anomaly, i.e. uterus didelphys. Findley quotes Stolper as having found 10 cases in 7,400 married women, and Neugebauer as finding 3 cases in 19,000 examinations, but whether the observations were made clinically or postmortem is not stated. Findley himself was able to collect from the literature 135 true cases of uterus didelphys up to 1926. With regard to the more common bicornate uteri, Falls says "the frequency is estimated to be 1 per cent," but gives no statistical proof of his statement.

As a rule doubling of the uterus does not assume clinical significance until the advent of pregnancy, and even at such a time the condition is frequently unrecognized. Many amusing reports occur in the literature concerning the confusion which has resulted from failure to recognize the abnormality. In breech presentations, when the septum is incomplete, one leg may pass down one side, the other leg down the other side, and the

From the Departments of Pathology and Surgery, College of Physicians and Surgeons, Columbia University, and the Surgical Service of the Presbyterian Hospital, New York.

Fig. 1. Appearance of ulcer of abdominal wall upon admission.

Fig. 2. Roentgenogram showing gas filled abscess cavities in thigh.

baby thus straddles the septum. Cases of superfetation are reported (22), one woman giving birth to a 7 months' infant, followed 3 days later by a fetus approximately 3 months in age. Confusion in diagnosis has resulted from the fact that one condition may be noted by the first observer on one side of the vaginal septum, while a consultant, who examines the other cervix, is unable to corroborate his colleague's impression. Diagnoses have been made of ovarian cysts, myomas, or even ectopic pregnancies. Women with double uteri conceive readily; 40 per cent, however, have complicated deliveries (21), and abortion and premature labor occur frequently; 17 per cent develop retention complications. There is unusual fertility in some cases. In one instance (21) there were delivered: 1 baby in the first pregnancy, 2 in the second, 3 in the third, 4 in the fourth, and 3 in the fifth, making a total of thirteen babies in five pregnancies! In the last labor the uterus ruptured.

Of the lesions associated with double uterus, hematometra is the most frequent. When it occurs on one side only, menstruation by the other uterus will confuse the diagnosis. As would be expected, dysmenorrhea is a common symptom.

Other lesions which have occurred in association with double uterus are: tumors of one cornua (polyps, 2; fibroma, 6; adenomyoma, carcinoma, 24; chorionepithelioma, 8; hematocolpos, salpingitis, 4; ovarian cysts, tumor in an hemi-atretic horn, 32; ovarian abscess, 4; inguinal hernia containing a horn of a bicornate uterus, 25; acute intestinal obstruction due to pregnancy in a bicornate uterus, 15; empyema of cervical cyst, 12). Several patients were operated upon with a diagnosis of acute appendicitis (17, 26).

Findley emphasizes the fact that absence of the right kidney and ureter is a frequent associated anomaly in this condition, and he suggests preliminary catheterization of the ureters before any operative procedures are done. In one instance in which hysterectomy was done, the only existing ureter was severed. In the case to be presented herewith, one kidney was absent.

We have been able to find records of comparatively few cases, however, in which infection played a prominent part in the clinical picture. Several of these were gonococcal in origin (8), while 2 developed a streptococcus peritonitis (9, 29). In the case reported by Mihailesco, a condition was found (pyocolpos and pyometros with retroperitoneal extension) which was very similar to the case to be presented.

The following case is reported as an interesting example of an uncommon uterine anomaly, associated with infection due to a micro-aerophilic hemolytic streptococcus.

B. S., female, age 24 years, Massachusetts textile mill worker, was admitted to Presbyterian Hospital, New York City, February 22, 1937. Unit history No. 511348. The family history was irrelevant. Patient had been married 8 years and had not been pregnant. Husband was living and well. Occupation—cotton spindle operator. She had had no previous illnesses or operations. Menstrual periods had

always been irregular, occurring every 14 to 21 days, always accompanied by severe dysmenorrhea; flow variable.

Patient was entirely well until 2½ years ago at which time she was suddenly seized with a sharp pain running from the lower lumbar spine to the right hip. This pain remained constant, did not radiate in any particular direction, was not associated with nausea, vomiting, change of bowel habits, genito-urinary or gynecological symptoms. The pain was at first severe enough to keep her home from work and to prevent sleep. There was no preceding history of trauma. After 3 days of treatment with hot water bags, the pain disappeared. After that she had similar attacks of pain, occurring several times a year, but between the attacks she remained quite well. A severe attack 9 months before admission was diagnosed as acute appendicitis. Operation was advised but refused and the pain gradually subsided. Fifteen weeks before admission the patient was seized with a similar attack of pain. The surgeon advised immediate operation, which was performed in the hospital in North Adams, Massachusetts. An abscess was found in the right lower quadrant of the abdomen and right side of the pelvis. The surrounding tissues were acutely inflamed and glued together with fibrinous exudate. The surgeon was not sure whether the appendix or the right tube was the primary focus of infection, and he decided to drain the abscess. A culture of the pus was reported to yield a hemolytic streptococcus. The wound continued to drain and the fever was maintained. Five weeks later the wound was reopened and another large abscess was found and drained. But this abscess likewise continued to drain profusely, and the patient suffered much pain. Her fever continued, her appetite failed, she lost weight and strength, and developed pressure sores on her back. Finally the region of the right hip became swollen and the right thigh tender and painful. She was seen in consultation by one of us (F.L.M.) in the North Adams Hospital. It was obvious that the infection had spread extensively and required further drainage. The doctors in charge of the case advised transferring the patient to New York for the purpose of further treatment. Although it was recognized that the risk of transportation was great, it seemed best to make the change. The trip of 180 miles was very tiring.

On arrival the patient was pale and emaciated and evidently in considerable pain and discomfort. The temperature was 101.6 degrees and the pulse was rapid. The eyes, ears, and nose were essentially negative. The mouth was dry, the tongue coated; the throat was normal. No enlarged glands were felt in the neck. The lungs were clear. The muscular tone of the heart was feeble, and there was a systolic murmur over the pulmonic area. The abdomen was moderately distended and everywhere tender. In the lower abdomen to the right of the midline was an ulcerated area with undermined margins. In the depths of the ulcer, a sinus led through the abdominal wall down toward the right lower quadrant. From it large quantities of pus were discharging (Fig. 1). The right lower quadrant above Poupart's ligament was bulging and there was a large area of fluctuation just beneath the skin. The upper third of the right thigh was swollen and edematous with fluctuation over Scarpa's triangle. Pressure here caused pus to pour forth from the abdominal sinus. The posterior surface of the thigh also revealed deep fluctuation. The hip joint, however, could be moved without great pain. The right leg as well as the whole left lower extremity showed considerable wasting.

The patient was obviously too sick to stand an immediate operative procedure. She was given fluids and a sedative. The white blood count was 11,700, with 65 per cent polymorphonuclear leucocytes. The urinalysis was negative. On the day after admission the patient seemed

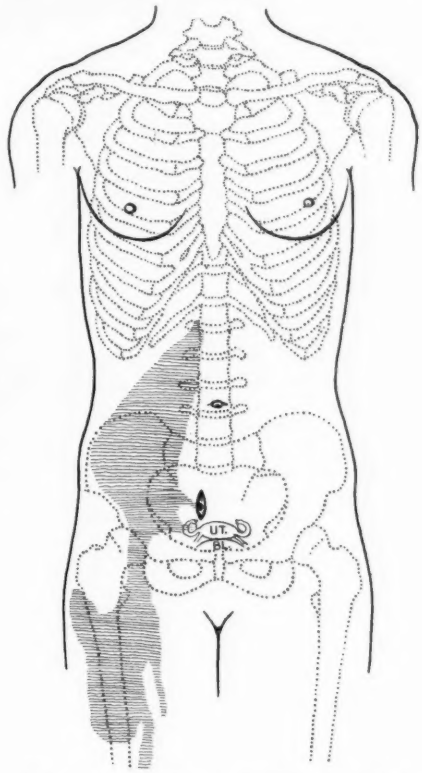


Fig. 3. Extent of abscesses as seen at operation.

a little better and stereoscopic films of the pelvis and right thigh were made before and after the injection of lipiodal into the abdominal sinus. The report follows: "The oil puddled along the psoas margins retroperitoneally, and the tip of the catheter extended as far as the first lumbar level. There is an obvious cavity with gas in it, lying in the anterior thigh region, and it is reasonable to suppose that the two cavities communicate. There is no evidence of bone pathology. The hip joint is not unusual" (Fig. 2).

On the third day the patient was very uncomfortable and cried whenever she was touched or moved, but her general condition was slightly improved. It seemed best not to delay the operation. Long incisions were made on the anterior and posterior aspects of the thigh and large quantities of pus were released from a cavity surrounding the upper third of the femur. This cavity extended upward along the iliopsoas muscle into the retroperitoneal space where a large mass of necrotic tissue lay in a huge abscess cavity. This abscess was drained through an oblique incision above Poupart's ligament (Fig. 3). The whole infected area was flooded with a suspension of zinc peroxide in distilled water. The wounds were lightly packed with gauze soaked in this suspension and the dressing was sealed with vaseline gauze.

Culture of the pus obtained at operation showed: a microaerophilic hemolytic streptococcus, an anaerobic non-

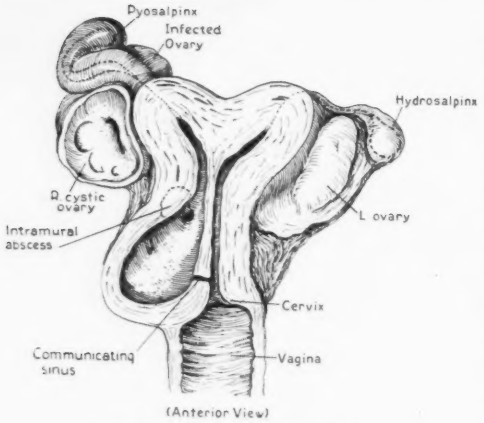


Fig. 4. Uterus bicornis duplex.

hemolytic streptococcus, an aerobic green streptococcus, a hemolytic and a non-hemolytic colon bacillus, and an anaerobic gram negative bacillus, Bacillus fusiformis necrophorus. The patient's condition was poor following operation. The blood pressure fell to 80/40, but after an infusion rose to 110/58. The white blood count fell to 6,500. On the morning of the day after operation the temperature fell and the patient seemed better although the pulse remained rapid. On the second postoperative day the patient went into shock and became comatose, the blood pressure falling to 90/40. An attempt was made to restore her with infusions, with cortin and with transfusion, but the pulse gradually failed, and she expired.

The necropsy (No. 12390) was performed 2¼ hours postmortem. The body was undernourished and poorly developed. There was a scar, 12 centimeters long, in the lower midline of the abdomen, its distal 8 centimeters gaping open to form an oval cavity 5 centimeters in width and 2 centimeters in depth. This cavity was lined with purplish red granulation tissue on which lay a fibrinous exudate and gray, coarsely granular powder (zinc peroxide). From the base of the cavity a sinus tract 1.5 centimeters in diameter extended inward. Recent, large, gaping incisions were present on the anterior and posterior aspects of the right thigh and another in the right lower quadrant of the abdomen parallel to Poupart's ligament and to the right iliac crest. These wounds extended deeply and were continuous with large cavities that completely surrounded the upper right femur and passed upward over the iliopsoas muscle to communicate with the retroperitoneal abscess cavity (Fig. 3). The walls of the cavities were lined with infected granulation tissue.

The peritoneal cavity contained 1200 cubic centimeters of turbid grayish yellow fluid in which were suspended flecks of fibrin. The peritoneum was everywhere injected, and fibrinous exudate bound together loops of intestine. The inflammatory reaction appeared to be recent.

The other abnormal findings were limited to the genitourinary system. The right kidney and ureter were absent. The left kidney was large, weighing 340 grams and measuring 15 by 7 by 4.5 centimeters. It was grossly and histologically normal. The bladder was normal except for the absence of the right ureteral orifice. Inflammation of the serosa was the only abnormality of the alimentary tract.

The uterus was large, measuring 8.5 centimeters in length, 6.4 centimeters in width, 2.5 centimeters in thickness. It was bicornate, and its general appearance and relationships are shown in Figure 4. The cervix of the left uterus was normal, except for the fact that its canal was 5 centimeters in length. There was no cervix on the right, the right uterine cavity terminating in a pear-shaped pouch 3.5 centimeters in its longest dimension. The inner surface of the pouch was smooth and glistening; its wall was found to be composed of dense fibrous tissue and smooth muscle, covered by granulation tissue. In places were patches of endometrial tissue containing glands. The two uterine cavities communicated with each other by means of a passage 1 millimeter in diameter through the septum, about 1 centimeter above the cervix. The cavities of the right uterus and of the blind "vaginal pouch" were filled with thick greenish pus, and a few drops of pus also were present in the left uterus, where it had extended via the communicating passageway. The tissues about the right uterus were indurated and in two places small cavities budded off the right uterine cavity where extension of the infection had occurred. There was a pyosalpinx on the right, and the right ovary was represented by several multiloculated cystic spaces, some of which contained pus. Communication between this infected ovary and the retroperitoneal abscess was demonstrated. There was a hydrosalpinx on the left, and the left tube and ovary were abnormally located, the tube lying mainly behind the fundus, the ovary against the body of the uterus.

The appendix showed no evidence of having been the primary focus of the infection. Fibrous adhesions pulled its tip down into the pelvis so that it lay lateral to the end of the right fallopian tube.

The left uterus was lined with normal endometrium, while the endometrium of the right one was atypical, there being fewer glands present, and in places areas of stratified squamous epithelium. The right fallopian tube presented a picture of subacute inflammation.

A culture of the pus obtained at the first operation, at the North Adams Hospital, yielded a hemolytic streptococcus. It is not certain whether this organism was obtained on direct plating of the pus or whether it appeared more slowly on liquid media. However, with the history of prolonged drainage of a pelvic abscess yielding on culture a micro-aerophilic hemolytic streptococcus, along with other intestinal organisms, it is reasonable to suppose that the hemolytic streptococci were the same. Either the organism was micro-aerophilic at the start or in the course of the prolonged infection it took on anaerobic properties.

Infections caused by the micro-aerophilic hemolytic streptococcus are characterized by prolonged suppuration with extensive burrowing. Although they are usually associated with infections of the skin and subcutaneous tissues producing chronic undermining ulcers, they also tend to burrow into the deeper tissues. In this case there was an undermining ulcer of the abdominal wall, but the principal lesion resulted from the burrowing of the infection upward along the psoas muscle to the lumbar region and downward into the thigh. The

formation of gas in the tissues indicated the activity of one or more of the contaminating organisms, either the anaerobic non-hemolytic streptococcus, the colon bacillus, or the Bacillus fusiformis necrophorus. Infection also terminally spread into the peritoneal cavity proper. It is not certain whether that spread occurred at the time of the operation and as a result of it, or a short while before. No communication was found between the abscess cavity and the peritoneum but a tiny opening might have been made in spite of the great care that was taken to avoid it at the time of the operation. In a similar case reported elsewhere (18) death occurred from peritonitis when the peritoneum was opened in an attempt to eradicate the infection by excision.

It is important to consider how this organism entered the patient. It may have come through the blood stream, perhaps gaining entrance from the throat, or from the intestine by direct extension from adherent loops of gut, or from the appendix. A more likely portal of entry was the anomalous uterus, for the following reasons:

1. The organism is occasionally found in the normal vagina.

2. Of 16 cases of infection with micro-aerophilic hemolytic streptococcus reported previously by one of us (F.L.M.,18, 19), 7 were pelvic infections in women, in whom the uterus and tubes were the probable portals of entry. The organism thus appears to have a predilection for the uterus and tubes.

3. Assuming that the organism gained entrance through the vagina, it must have entered the left uterus and either have passed through the opening in the septum to the right side or have passed through the left tube into the pelvis and thence to the right side. The infection may have become established in the right "vaginal pouch" with subsequent spread to the right uterus, tube, and ovary, or it may have started first in the tube, with later extension to the ovary and uterus. The microscopic study showed the inflammatory changes in the tube to be of longer duration and greater severity than those in the uterus. It is likely that a long standing hematometra or hematocolpos served as a *locus minoris resistentiæ* that favored the establishment of the infection.

It is probable that the infection could never have been eradicated in this case because of the nature of the congenital anomaly. Any attempt at removal of the infected uterus and tube from above would almost certainly have caused a fatal peritonitis. Drainage from below would have been ineffective. In either event it would have been impossible to obtain contact between the zinc peroxide and the deepest foci of the infection in the uterus and tube. It is possible that sulphanilamide might have had a beneficial effect on the hemolytic streptococcus if it had been used in the early stages of the disease, but it would have had no effect during the later stages when other organisms were present.

REFERENCES

1. Arósteguí. An. de cir., 1929, 1: 60.
2. Atkinson and Masson. Surg. Clin. N. America, 1934, 14: 571.
3. Brodhead. J. Am. M. Ass., 1920, 74: 1453.
4. Carrington. Am. J. Obst. & Gynec., 1933, 25: 924.
5. Catlin. J. Am. M. Ass., 1924, 82: 2030.
6. Cornell and Earle. Surg., Gynec. & Obst., 1919, 29: 485.
7. Danesi. Semana méd., 1935, 1: 368.
8. del Vivo. Riforma med., 1926, 42: 295.
9. Epstein and Goldberg. Am. J. Obst. & Gynec., 1929, 18: 342.
10. Falls. Am. J. Obst. & Gynec., 1928, 15: 390.
11. Findley. Am. J. Obst. & Gynec., 1926, 12: 318.
12. Freisfeld. Zentralbl. f. Gynaek., 1936, 60: 1030.
13. Halperin. Am. J. Surg., 1931, 14: 637.
14. Irvine. Indian M. Gaz., 1936, 71: 339.
15. Jackson. Brit. M. J., 1920, 1: 185.
16. Kerwin. Am. J. Obst. & Gynec., 1925, 9: 369.
17. Martindale. Lancet, 1935, 1: 1389.
18. Meleney. Ann. Surg., 1935, 101: 997.
19. Meleney and Johnson. Surgery, 1937, 1: 169.
20. Mihailesco. Gynéc. et obst., 1927, 15: 205.
21. Miller. Am. J. Obst. & Gynec., 1922, 4: 398.
22. Moench. Am. J. Obst. & Gynec., 1927, 13: 60.
23. Moore. New England J. Med., 1933, 208: 887.
24. Motta. Clin. Ostet., 1934, 36: 215.
25. Mouat. Brit. M. J., 1926, 1: 237.
26. Poindexter. Texas State J. Med., 1931, 26: 665.
27. Puddicombe. Surg., Gynec. & Obst., 1929, 49: 799.
28. Rockey. Ann. Surg., 1916, 63: 615.
29. Roth. Bull. Soc. d'obst. et de gynéc., 1928, 17: 144.
30. Schumann. Am. J. Obst., 1911, 64: 626.
31. Idem. Nelson's Loose-Leaf Living Surgery, vol. 7, chapter 36, p. 703.
32. Schwarz. Am. J. Obst., 1918, 77: 583.
33. Strassmann. Zentralbl. f. Gynaek., 1907, 31: 1322.
34. Sweeney. Northwest Med., 1933, 32: 63.
35. Wardlow and Smith. Surg., Gynec. & Obst., 1922, 35: 497.

EDITORIALS

SURGERY
Gynecology and Obstetrics

FRANKLIN H. MARTIN, M.D.
Founder and Managing Editor
1905–1935

ALLEN B. KANAVEL, EDITOR

Associates
LOYAL DAVIS
SUMNER L. KOCH MICHAEL L. MASON

DONALD C. BALFOUR, *Associate, Editorial Staff*

JANUARY, 1938

IMMEDIATE VERSUS DELAYED SURGERY IN ACUTE CHOLECYSTITIS

THE surgical management of acute cholecystitis has long been a subject of discussion because of differing opinions regarding the advantages of immediate rather than delayed surgery in this condition. Years ago, surgical opinion was preponderantly in favor of delay in operating for acute cholecystitis until the active inflammatory process had subsided. In recent years, however, this viewpoint is definitely changing as shown in papers by Miller, Stone and Owings, Andrews, Heuer, and others; and an increasing number of surgeons are finding immediate cholecystectomy the treatment of choice in acute cholecystitis. Further evidence of the changing modern viewpoint was recently given in the editorial by Heyd in this Journal. Immediate operation in acute cholecystitis is the treatment of choice in my opinion, not only because clinical experiences with it have been good but also because it is my belief that the pathological condition present makes early operation positively indicated.

Most students of the pathology of acute cholecystitis now agree that obstruction to the cystic duct is the primary lesion in this disease, and that infection, when it occurs in these cases, is a secondary phenomenon which is dependent on this obstruction for its development. Usually a stone causes the obstruction to the cystic duct. Following this obstruction, comes swelling of the gall bladder with resultant pressure on the veins and lymphatics that lie in close relation to the tortuous folds of the cystic duct. In some cases, branches of the cystic artery are occluded and infarction of parts of the gall-bladder wall appear. Gangrene and even perforation may occur if the edema, infarction, and necrosis advance. The time necessary for these changes to appear after a stone is impacted in the cystic duct will vary with the completeness of the obstruction to the duct and with the anatomical arrangement of the blood vessels in the individual case.

Studies of the bacteriology of acute cholecystitis by Wilkie, Denton, Feinblatt, Andrews, and others have all shown that *infection* of the gall bladder is *not* the primary etiological factor in acute cholecystitis. Most workers agree with Feinblatt and with Denton that the rôle of infection as a cause of cholecystitis has been greatly overestimated. The recent studies by Andrews show that bacterial infection plays a very minor rôle in this disease. All recent students of the bacteriology of acute cholecystitis agree that metabolic, mechanical, or circulatory changes must be present in the gall bladder before bacterial infection will occur.

Clinically, these findings are confirmed by the course of many cases of acute cholecystitis in which patients are operated upon within 48 hours of the onset of their pain. Such patients reveal at operation tensely distended, edematous, red gall bladders. Yet their course following immediate cholecystectomy is generally very much like the course of any laparotomy for a non-inflammatory lesion. In some respects the early case of acute cholecystitis resembles that of the early case of an ovarian cyst with a twisted pedicle. Basically, the pathology of the two conditions is an interference with the blood supply of an intraperitoneal viscus. In each case, therefore, immediate surgery is a logical procedure. In neither situation, certainly, is the fundamental pathology a "septic process."

A recent study of a series of cases of acute cholecystitis has impressed me with the advantages of the immediate over the delayed operation. By "immediate operation," I refer to operations, usually cholecystectomy, carried out within 2 to 3 days of the onset of pain. It is perhaps unnecessary to say that in every one of these cases there is always time to prepare for this surgery by the administration of fluids and glucose. In my experience, when operation has been done within 48 hours of the onset of the attack, complications are few, hospital stays are short, and there is no mortality. When the operation is performed late in the disease, complications due to infection are common, perforation is found in 14 per cent, hospital stays are long, and secondary operations are often necessary.

It is my belief that cystic duct obstruction is the first event in the pathological process of acute cholecystitis and that infection, when it is present, is secondary to cystic duct obstruction. Immediate removal of the gall bladder, therefore, in the early cases of acute cholecystitis seems indicated as soon as the diagnosis is apparent and before infection, with its complications, has appeared.

HOWARD M. CLUTE.

CONCERNING THE TERM "SHOCK"

IT IS one of the common generalizations of economics that money of low value drives out of circulation that of higher value. Similarly in the use of words, those with a low content of precise meaning and therefore widely applicable, frequently displace those more accurate terms which are more limited in scope or at least impede the introduction of such. Some words have a specious appearance of precision and in that respect resemble counterfeit money, and one of these is the term "shock."

Defining a word serves the same purpose as assaying the metallic content of a coin and will frequently disclose the baseness of its content. In attempting to do this with "shock," it is soon discovered that it only represents a congeries of symptoms and signs which is characteristic of no one mechanism or etiological factor, without it be the condition of the observer's mind. It is in short one of those words "which cloak the unknown in the indefinable."

Yet the fact that it is in current and common usage signifies that it meets some demand —a demand which should be satisfied by a more cogent term.

In the early nineteen hundreds when "shock" began to be more intensively studied with the resulting popularization of the term, the concept was broadened by Romberg beyond the common idea that it was associated only with surgery, by indicating that it was in essence a failure of the circulation of the blood which occurred as a terminal phenomenon in many diseases including those caused by specific

infectious agents. Recently this same concept has been revived and given the horrific name of "medical shock," which distributes the disgrace of the term even more widely.

During these years, as the result of many investigations, it has come to be understood that failure of the circulation of the blood is usually due to either a deficient propulsive force—cardiac failure—or inadequacy of the distributive apparatus, that is to say, vascular failure. That the latter is most frequently due to a decrease of blood volume as a result of the inability of the blood vessels to retain all or some of the components of its contents, does not invalidate the significance of the term, vascular failure.

It would seem reasonable then to abandon the inexact and misleading word "shock" and replace it with *cardiac failure* or *vascular failure* depending upon whether the propulsive or the distributive mechanism is primarily involved. With either of these, the causative factor may be named so as to complete the picture.

SAMUEL C. HARVEY.

FAMOUS AUTOGRAPHS

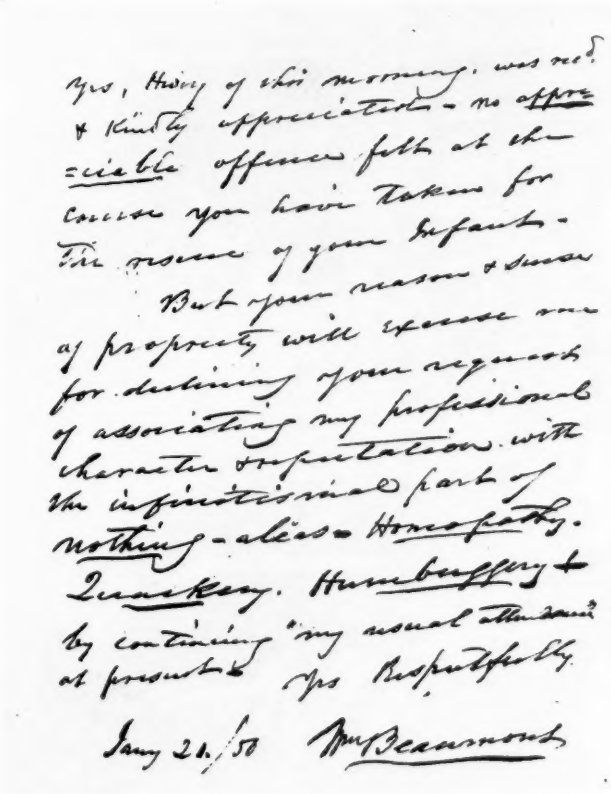
THREE DOCTOR WILLIAM BEAUMONT LETTERS

ARNO B. LUCKHARDT, Ph.D., Chicago, Illinois

MANY of the biographical sketches of Dr. William Beaumont that have appeared from time to time and are still appearing, though interesting and stimulating, consist essentially of a reiteration—sometimes almost *verbatim*—of previous authors. The legend, and lore, and the facts concerning William Beaumont will bear repetition.

From the Physiological Laboratories, The University of Chicago.

The interest taken in him and his accomplishments are highly commendable. This man, whose achievements merit canonization as the patron saint of American Medicine, has been sadly overlooked by the profession. He will always remain a model for bed-side solicitude, self-sacrifice, research in the clinic and laboratory, and accomplishment under trying conditions that required dogged persistence and the necessary drive to carry on in spite of the



Yrs, Hasty of this morning. was rec'd
& kindly appreciated - no appre-
=ciable offence felt at the
course you have taken for
the reason of your infants -
But your reason & assur
of propriety will excuse me
for declining your approach
of associating my professional
character or reputation with
the infinitissimal part of
Nothing - alias - Homeopathy.
Quackery. Humbuggery &
by continuing my usual attendance
at present to Yrs Respectfully
Jany 21./50 Wm Beaumont

Facsimile of letter written by Wm. Beaumont in January of 1850. His irritation at insult to his profession is very evident.

St Louis Mo
Mar 4. 1851

Yrs Buddy of 16th ult. is just rec'd and it's contents considered with special interest & pleasure.

I shall avail myself of yr suggestion and embrace the earliest opportunity of forwarding you sufficient authority to locate two Warrants for a qtr Section each upon the best tract you can in the Military Reserve at Ft Howard and vicinity: or any other eligible land in the State — But the latter to secure a good location. I will suggest that you go on, select the best site you can, Squat, stake your stakes, build a hut or log pen or chickencoop for preemption sake: till you receive the Warrants to cover the same or more —

Consult with Uncle Tommy. Mr Martin or Major Shaler on the subject —

I forwarded my claimes, in due form for myself & Sarah, soon after the act was passed, to the proper Department, this October last, to the Care of Col Kinchesek, who prosecuted them in person and made favorable report, and I am daily expecting the Warrants. — 160 acres each — 320. total — so soon as rec'd I shall send them over to you with instructions —

If possible to leave my business I shall come over this Spring. If I can not, your mother will, most likely come with Blake, and I may come after —

Yours, of 11th ult. has also been rec'd and perused, with much pleasure and satisfaction — I shall write you again soon in answer to your inquiries &c. —

We are all pretty well now — have been a little unwell with bad colds a week or two since —

Love to you all — let me hear from you often and believe me

Yr affectionate
Father

To Sly Beaumont
Green Bay
Wisconsin

Facsimile of letter of Wm. Beaumont, written in March of 1851, showing his sagacity in business matters.

irresponsibility and untrustworthiness of Alexis St. Martin, and the obstacles furnished by nature and the malicious designs of members of his own profession.

These letters, represent a psychological cross section of the man, Beaumont, in several moods. One of them Dr. Beaumont wrote while irritated because he felt himself insulted professionally; the second, gives ample evidence that Dr. Beaumont was possibly not naive in business matters; and the last, in simple transcription, is a Christmas letter to his son, Israel Green Beaumont, which ends with an improvised poem portraying the affectionate father.

These letters are a part of an invaluable collection of Beaumontiana consisting of letters, personal effects, and various documents which will throw new and interesting light on Beaumont, his family, friends, business and military associates, and on the times in which he lived. During the spring of 1936, the University of Chicago was made the beneficiary, through the generosity of Mr. and Mrs. E. A. Beaumont, of DePere, Wisconsin, of this documentary material, which permits of a new and better evaluation of America's "Backwoods Physiologist."

Saint Louis, Missouri

Christmas Eve
Dec. 25, 1850

A merrie morrow to you—Bud—and may you enjoy it right merrily and morally with all our relations and friends there.

And now you are on the spot and no doubt competent and feel confident in your own judgment, aided if necessary by timely counsels of your friends to manage my interests at the Bay for our mutual benefit and satisfaction. . . .

I shall submit the following subject and suggestions to your and Uncle Tommy's consideration and disposal:— (Then follows directions relating to the handling of certain real estate located at Green Bay**********)

If you prove yourself pretty shrewd and discrete in this, I shall probably afford you other opportunities to exercise and improve your business faculties in the disposal of other parts of the property next season. I can add nothing to the information of my last a few days since. All in health and everything as usual.

Christmas has just come—and I must-go-to-bed 12½ O'c'k a.m. and all the rest are asleeping—your Father-just-agoing—nod-ding—go-i-n-g-to-sl-e-e-p."

6 o'k morning—all wide awake—
And *kissing*—for old Nick's sake—
Lapping lasses and Buckwheat cakes,
Sipping coffee—eating venison steaks—
Oyster soup and chicken fixings—
Hot rolls and butter made from strippings

Let us hear of your doings *soon*, and gratify your father
W.B.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

AN excellent review of what is at present known of the physiology and clinical endocrinology of obstetrics and gynecology is presented by Kurzrok in his recent book.[1] Each section is followed by a valuable bibliography. The first third of the work is devoted to the physiology and chemistry of all the endocrine glands. The endocrinology of menstruation, ovulation, uterine motility, pregnancy and lactation, is then discussed. Much of the author's own work has had to do with hormone assay in clinical ovarian syndromes. Hence, the chapters on amenorrhea, functional uterine bleeding, dysmenorrhea, the menopause, the toxemias of pregnancy, precocious maturity, intersexuality, and sterility are particularly interesting. Case reports include the results of hormone titrations. The book concludes with a chapter on methods of hormone assay.

One pleasant quality of the work is the frankness with which ignorance is admitted. As a result, the author is able to indicate the next steps to be taken in research. Thus, many problems are suggested. The approach to the clinical diagnosis and therapy is by definite deduction from established physiology. Hormone assay is used to demonstrate the functional relationships which exist in the patient. As a result this volume marks a definite advance over other endocrine treatises recently published.

PAUL STARR.

[1]THE ENDOCRINES IN OBSTETRICS AND GYNECOLOGY. By Raphael Kurzrok, Ph.D., M.D. Baltimore: The Williams & Wilkins Co., 1937.

A SMALL, well bound volume, well printed on good paper, is *Practical Talks on Kidney Disease*.[2] The book is broken into the usual topics when renal and vascular diseases are discussed. The author states that "this small volume is designed to assist the physician who practices general medicine to understand what is generally regarded as a difficult and confused subject It is not intended as a monograph or text book." The author further states that he is "aware of the dangers in attempting to deal simply with such complex subjects and I plead guilty to many errors of omission which, however, can be easily corrected by further reading in certain books from which I have borrowed freely." The latter statement covers the main fault of the book. The material is incompletely and casually presented so that one seeking aid would be generally disappointed. General practitioners who are interested in therapy will not find an organized or aggressive program.

The author properly warns against the careless use of large doses of acid or alkali producing salts because of the ease of disturbing acid base equilibrium. He also ridicules the assaults which have been made all too frequently upon the hypertensive individual by needless dietary restriction, tooth extraction, and like procedures.

M. HERBERT BARKER.

[2]PRACTICAL TALKS ON KIDNEY DISEASE. By Edward Weiss, M.D. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1937.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

MEDICAL RECORDS IN THE HOSPITAL. By Malcolm T. MacEachern, M.D., C.M., D.Sc., F.A.C.P., F.A.C.H.A. Chicago: Physicians' Record Co., 1937.

PRIMARY CARCINOMA OF THE LUNG. By Edwin J. Simons, M.D. Chicago: The Year Book Publishers, Inc., 1937.

ARTIFICIAL FEVER; PRODUCED BY PHYSICAL MEANS, ITS DEVELOPMENT AND APPLICATION. By Clarence A. Neymann, A.B., M.D., F.R.S.M. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1937.

MEDIZINISCHE PRAXIS; SAMMLUNG FUER AERZTLICHE FORTBILDUNG. Edited by L. R. Grote, A. Fromme, and K. Warnekros. Vol. 24—DER VITAMINHAUSHALT IN DER SCHWANGERSCHAFT. By Dr. med. Gerhard Gaehtgens. Dresden and Leipzig: Theodor Steinkopff, 1937.

INSUFFLATION TUBAIRE KYMOGRAPHIQUE PAR LA MÉTHODE DE RUBIN; ÉTUDE DE LA PERMÉABILITÉ ET DU FONCTIONNEMENT DES TROMPES PARTICULIÈREMENT EN VUE DE LA STÉRILITÉ. By Louis Bonnet. Paris: G. Doin & Cie, 1938.

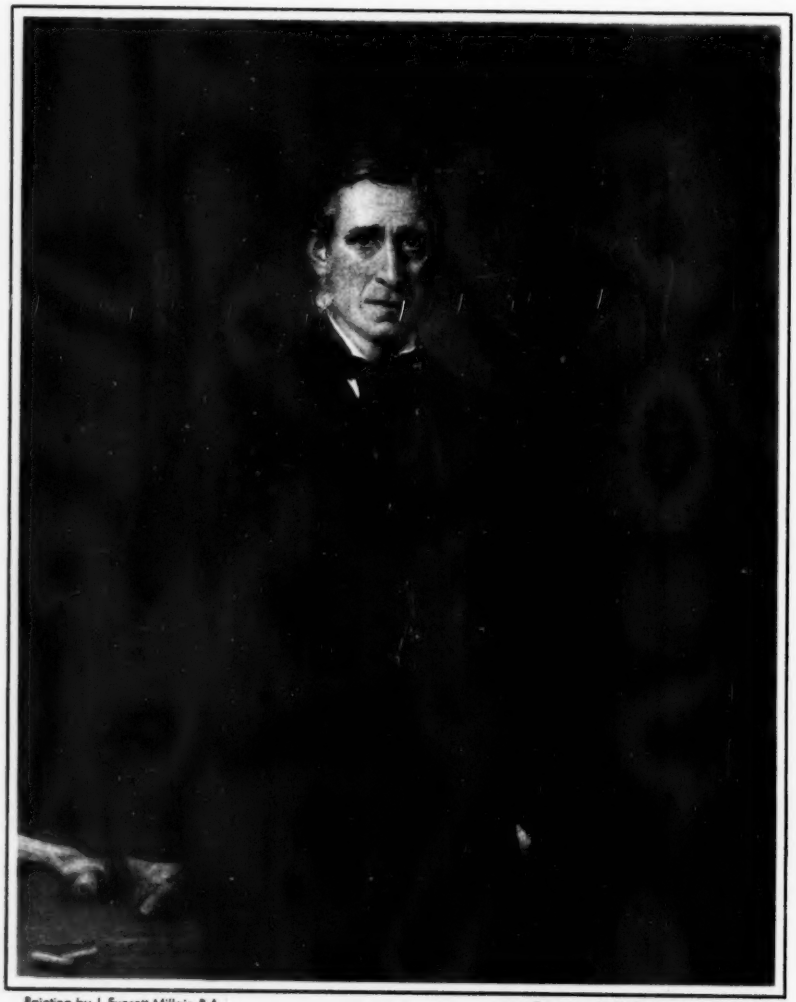
LA TACTIQUE OPÉRATOIRE. Published under the direction of M. Robineau and W. Stern. TACTIQUE OPÉRATOIRE GASTRO-DUODÉNALE. By M. Chaton and W. Stern. Vols. 1 and 2. Paris: G. Doin & Cie, 1938.

SURGICAL ANATOMY OF THE HEAD AND NECK. By John Finch Barnhill, M.D., F.A.C.S., LL.D. Introduction by Paul S. McKibben. Baltimore: William Wood & Co., 1937.

A METHOD OF ANATOMY; DESCRIPTIVE AND DEDUCTIVE. By J. C. Boileau Grant, M.C., M.B., Ch.B., F.R.C.S. (Edin.). Baltimore: William Wood & Co., 1937.

THE SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM. By George E. Gask, C.M.G., D.S.O., F.R.C.S.(Eng.), and J. Paterson Ross, M.S.(Lond.), F.R.C.S.(Eng.). 2d ed. Baltimore: William Wood & Co., 1937.

GENITAL ABNORMALITIES, HERMAPHRODITISM, AND RELATED ADRENAL DISEASES. By Hugh Hampton Young, M.A., M.D., Sc.D., F.R.C.S.I., D.S.M. Baltimore: The Williams & Wilkins Co., 1937.



Painting by J. Everett Millais, R.A. Engraving by T. Oldham Barlow, A.R.A.

Sir James Paget

1814-1899